"EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION" –A PROSPECTIVE STUDY

Dissertation submitted to

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment for the award of the degree of

DOCTOR OF MEDICINE
IN
ANAESTHESIOLOGY
BRANCH X

INSTITUTE OF ANAESTHESIOLOGY AND CRITICAL CARE
MADRAS MEDICAL COLLEGE
CHENNAI- 600003

APRIL 2018

CERTIFICATE

This is to certify that the dissertation titled, **"EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION –A PROSPECTIVE STUDY** " Submitted by **Dr.G. ARUN SEKAR** in partial fulfillment for the award of the degree of DOCTOR OF MEDICINE in Anaesthesiology to The Tamilnadu Dr.M.G.R Medical University, Chennai is a bonafide record of work done by him in the INSTITUTE OF ANAESTHESIOLOGY& CRITICAL CARE, Rajiv Gandhi Govt General Hospital, Madras Medical College, Chennai during the academic year 2015-2018.

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CERTIFICATE OF THE GUIDE

This is to certify that the dissertation titled , **"EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION –A PROSPECTIVE STUDY" Submitted** by **Dr.G.ARUN SEKAR** in partial fulfillment for the award of the degree of **DOCTOR OF MEDICINE** in Anaesthesiology, to The Tamilnadu Dr.M.G.R Medical University, Chennai is a bonafide record of work done by him in the INSTITUTE OF ANAESTHESIOLOGY& CRITICAL CARE, Rajiv Gandhi Govt General Hospital, Madras Medical College, Chennai during the academic year 2015-2018.

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Date:
Place: Chennai

DECLARATION

I Dr. **G.ARUN SEKAR**, hereby declare that the dissertation titled, **"EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION –A PROSPECTIVE STUDY"** is a bonafide work done by me under the guidance of **Prof.Dr.N.LATHA,M.D,D.A**, Professor of Anaesthesiology, Institute of Anaesthesiology & Critical care, Madras Medical college, Chennai, and submitted to The Tamilnadu Dr.M.G.R Medical University, Chennai in partial fulfilment of the regulations for the award of the degree of MD (Anaesthesiology), examinations to be held in April 2018.

This study was conducted at Institute of Anaesthesiology & Critical care, Madras Medical College, Rajiv Gandhi Govt. General Hospital, Chennai.

I have not submitted this dissertation previously to any journal or any university for the award of any degree or diploma.

Date:
Place: Chennai Dr.**G.ARUN SEKAR**

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I am thankful to institutional ethics committee for the approval and guidance for this study. My sincere thanks to the statistician, who played an important role during my study.

I express my sincere thanks to my parents, sister (Dr.G.Lathika) and wife who were behind me with extreme moral support and encouragement.

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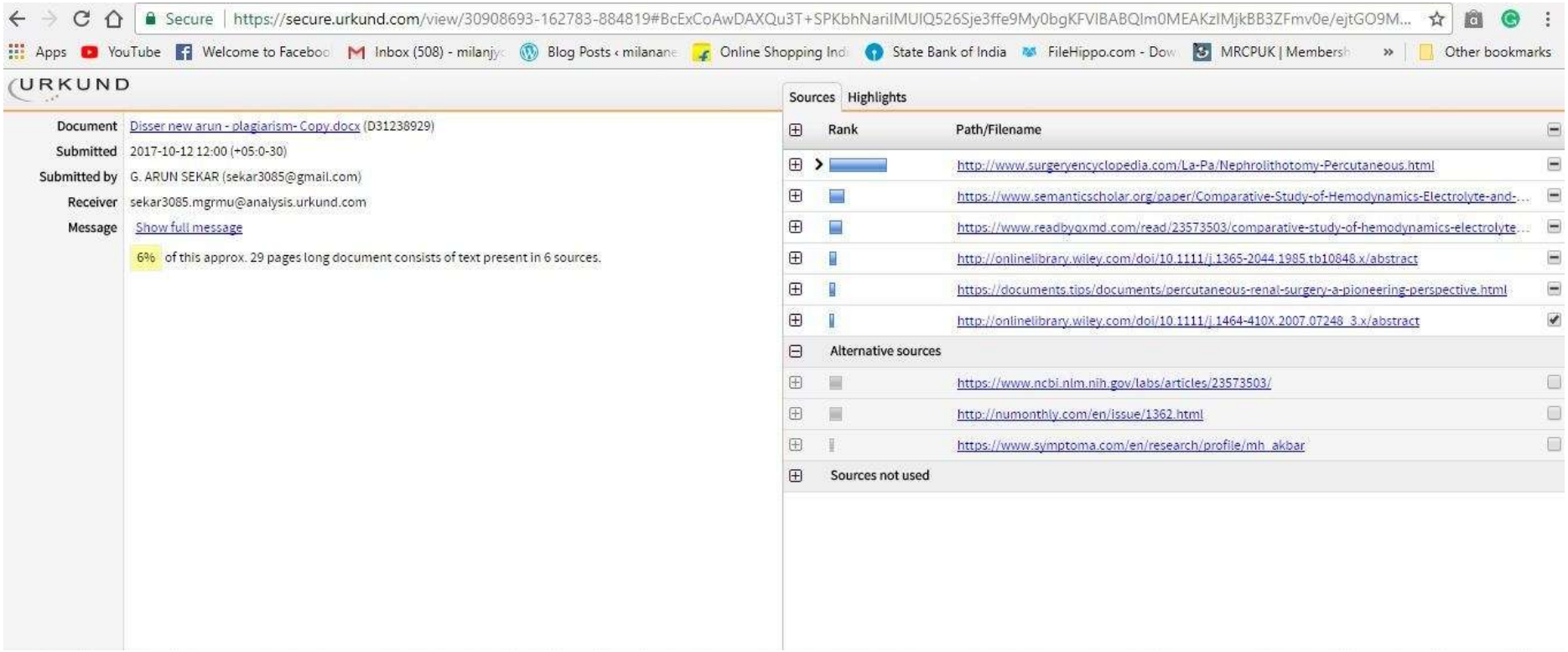
Lastly I am extremely thankful to Almighty and all the patients and family members for willingly submitting themselves for my study.

Dr.**G.ARUN SEKAR**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PLAGIARISM CERTIFICATE

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CERTIFICATE OF APPROVAL

To
Dr.G.Arun Sekar
II Year Post Graduate in MD Anaesthesiology
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Madras Medical College
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Dear Dr.G.Arun Sekar,

The Institutional Ethics Committee has considered your request and approved your study titled **"EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION" - NO.08022017 (II)**

The following members of Ethics Committee were present in the meeting hold on **21.02.2017** conducted at Madras Medical College, Chennai 3

1.Dr.C.Rajendran, MD.,	:Chairperson
2.Dr.M.K.Muralidharan,MS.,M.Ch.,Dean, MMC,Ch-3	:Deputy Chairperson
3.Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3	: Member Secretary
4.Prof.B.Vasanthi,MD., Prof.of Pharmacology.,MMC,Ch-3	: Member
5.Prof.K.Ramadevi,MD.,Director,Inst.of Bio-Che,MMC,Ch-3	: Member
6.Tmt.J.Rajalakshmi, JAO,MMC, Ch-3	: Lay Person
7.Thiru S.Govindasamy, BA.,BL,High Court,Chennai	: Lawyer
8.Tmt.Arnold Saulina, MA.,MSW.,	:Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

14/3/17

Member Secretary - Ethics Committee

MEMBER SECRETARY
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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is a surgical procedure done for the treatment of renal stones. PCNL has the advantages of decreased blood loss, reduced post-operative pain, faster recovery, and minimal scar tissue formation. The procedure involves continuous irrigation of kidney with the use of irrigation fluid for better vision, to wash away the stone fragments and blood clots. Normal saline (0.9% NaCl) is the most commonly used irrigation solution.

The irrigation fluid absorption occurs either by direct intravascular route through opened veins or intraperitoneally after opening of the intra peritoneal space with peritoneal resorption. The systemic absorption of significant volumes of irrigation fluid may result in fluid overload, electrolyte imbalance, hemodynamic instability and neurological problems.

There were many studies done in patients undergoing PCNL procedures to evaluate the metabolic, electrolyte and haemodynamic changes and to correlate these changes with irrigation fluid parameters like duration of irrigation, volume of irrigation fluid absorbed and number of percutaneous interventions. Apart from normal saline, distilled water, mannitol, glycine are also used for irrigation during PCNL.

AIM OF THE STUDY

The purpose of study were to evaluate electrolyte and metabolic changes in patients undergoing PCNL using Normal Saline as irrigation solution and to correlate these changes with duration of irrigation and volume of irrigation fluid infused.

PRIMARY OBJECTIVES

- Serum Sodium, Potassium, Chloride, pH & Bicarbonate values were recorded in Preoperative (baseline), Intraoperative (30 mins after irrigation) and in Postoperative periods.
- To correlate the above electrolyte and metabolic changes with duration of irrigation and volume of irrigation fluid infused.

SECONDARY OBJECTIVES

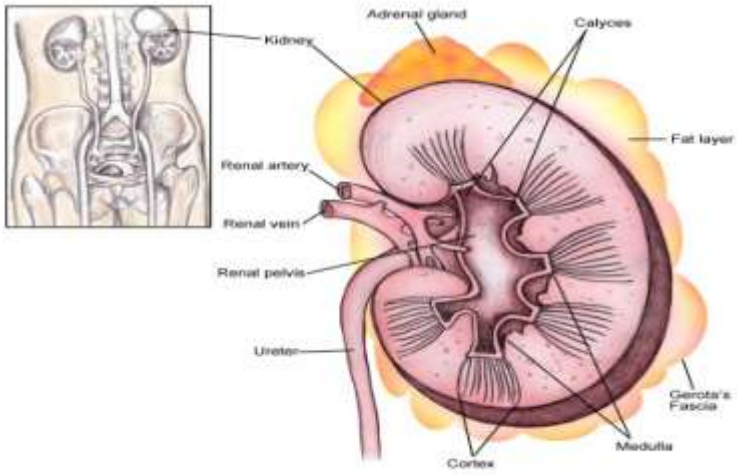
- To compare preoperative and postoperative Haemoglobin levels.

ANATOMY OF KIDNEY

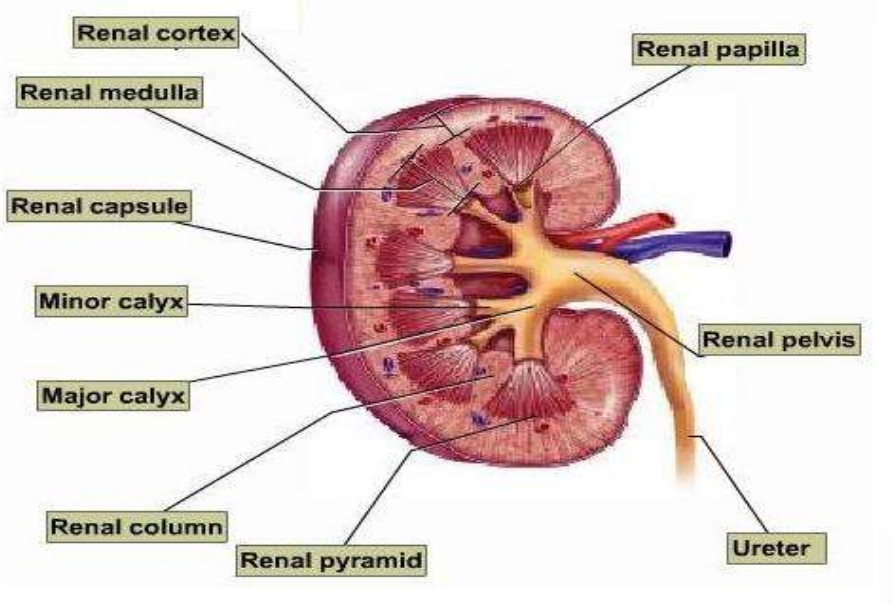
The kidneys are paired retroperitoneal organs that are normally located between the transverse processes of T12-L3 vertebrae. The kidneys are bean-shaped structures and weigh about 150 g in the male and about 135 g in the female. They are typically 10-12 cm in length, 5-7 cm in width, and 2-3 cm in thickness, with the left kidney more superior in position than the right. The upper poles are normally oriented more medially and posteriorly than the lower poles. The kidneys serve important functions, including filtration and excretion of metabolic waste products (urea and ammonium); regulation of necessary electrolytes, fluid, and acid-base balance; and stimulation of red blood cell production. They also serve to regulate blood pressure via the renin-angiotensin-aldosterone system, controlling reabsorption of water and maintaining intravascular volume. The kidneys also reabsorb glucose and amino acids and have hormonal functions via erythropoietin, calcitriol, and vitamin D activation.

Superiorly, the suprarenal (adrenal) glands sit adjacent to the upper pole of each kidney. On the right side, the second part of the duodenum (descending portion) abuts the medial aspect of the kidney. On the left side, the greater curvature of the stomach can drape over the superomedial aspect of the kidney, and the tail of the pancreas may extend to overlie the renal hilum.
The spleen is located anterior to the upper pole of left kidney and is connected by the splenorenal (lienorenal) ligaments. Inferiorly to these organs, the colon

typically rests anteriorly to the kidney on both sides. Posteriorly, the diaphragm covers the upper third of each kidney, with the 12th rib most commonly crossing the upper pole. The kidneys sit over the psoas (medially) and the quadratus lumborum muscles (laterally).



Each kidney has two distinct regions - outer cortex and an inner medulla. The medulla is composed of numerous renal pyramids. At the innermost ends of the pyramids are calyces which receive urine, which then drain to the renal pelvis and the ureter.

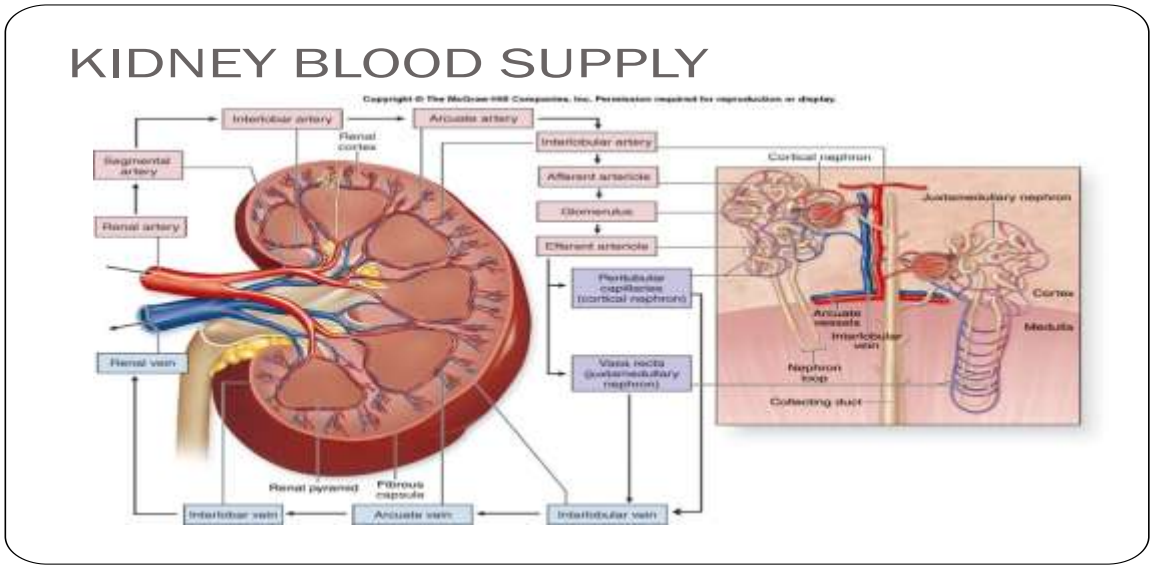


RENAL BLOOD FLOW (RBF) :

The kidneys receive a total blood flow of approximately 1000ml per minute (20% of the cardiac output). This equates to 300 – 400ml per minute per 100g of tissue which is approximately six times that of the brain and five times that of the heart. Kidneys oxygen consumption is determined by blood flow. The blood flow is not evenly distributed throughout the kidney.

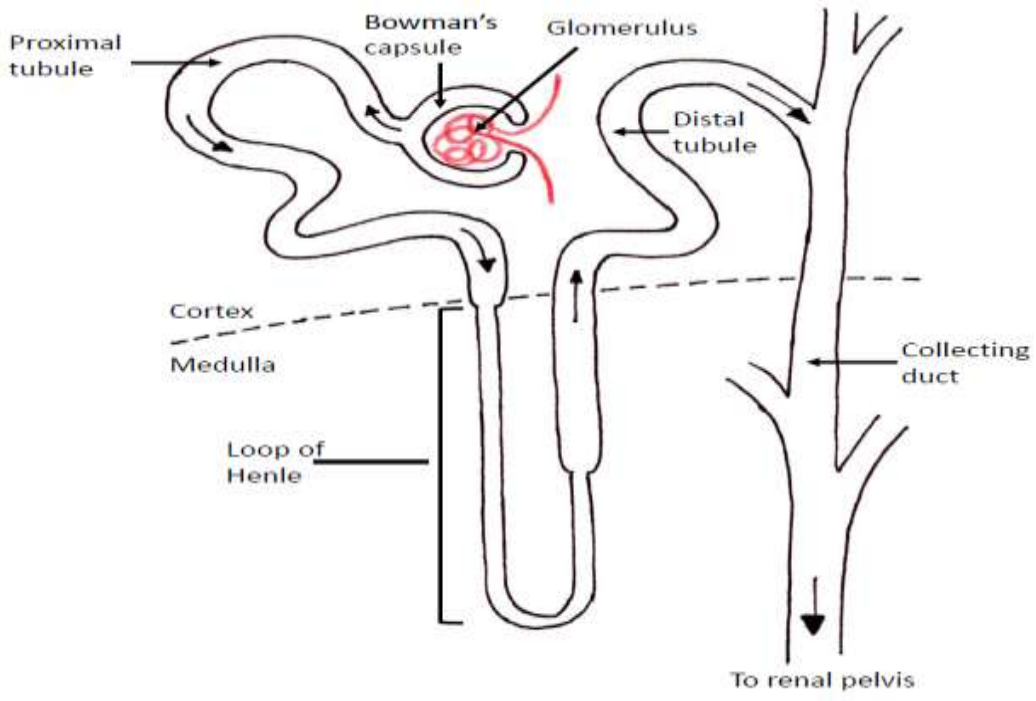
❖ Renal cortex- The cortex receives 90% of blood flow, which is the least metabolically active and extracts only little oxygen. It receives high blood flow with mostly filtration function. Cortex blood flow – 500ml/100g/min.

❖ Renal medulla- only 10% of blood goes to the more metabolically active Medulla and this high metabolic activity due to solute reabsorption and requires low blood flow to maintain high osmotic gradients-relatively vulnerable to ischaemia. Outer medulla blood flow – 100ml/100g/min, Inner medulla blood flow – 20ml/100g/min.



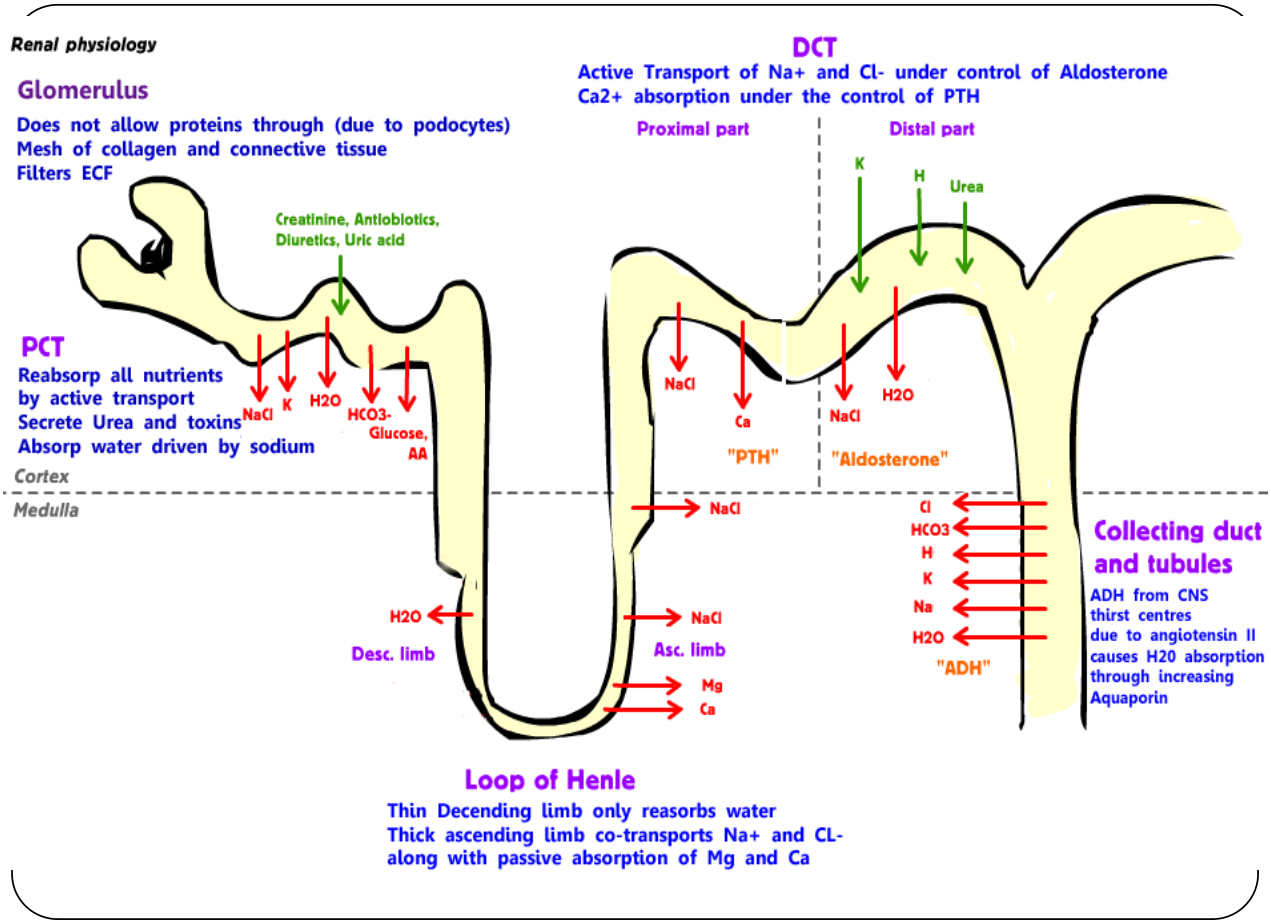
NEPHRON :

The basic functional unit of the kidney is the nephron. Each kidney contains approximately 1 – 1.5million nephrons. Each nephron contains complex capillary network proximally and a capsule where plasma is filtered (the glomerulus and Bowman's capsule), which produces the glomerular filtrate, and situated distally are the collecting ducts from which urine drains. Between Bowman's capsule and the collecting duct is the proximal convoluted tubule (PCT), the loop of Henle and the distal tubule, each of which serve specific functions. The nephrons are all orientated such that the glomerulus and Bowman's capsule lie in the cortex with their loop of Henle and collecting duct pointing towards and entering the medulla.



FILTERATION FUNCTIONS OF KIDNEY

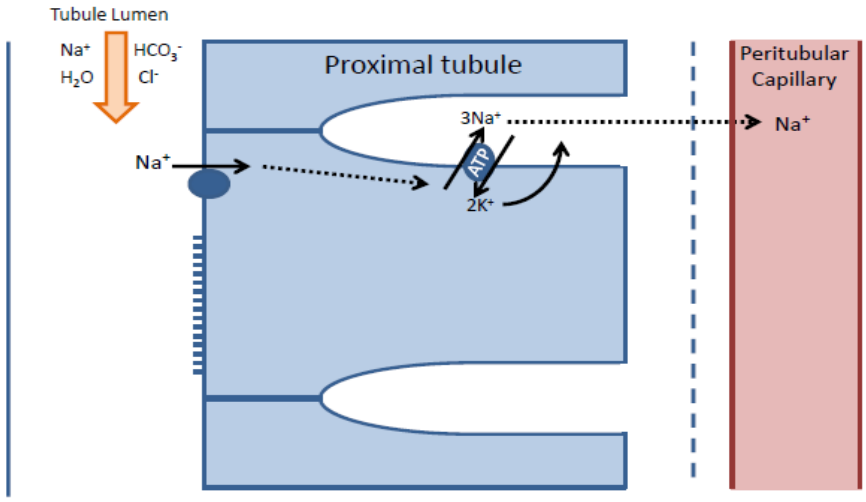
The proximal tubule receives glomerular filtrate from the Bowman's capsule. Overall the proximal tubules receive 180L/day of glomerular filtrate and reabsorb approximately 70% (127L/day). The most important substances to be reabsorbed in the proximal tubules are sodium (Na+ -70%),bicarbonate (HCO_3- -90%), chloride (Cl- -70%),glucose(100%),albumin (100%), water(70%),urea 50%,aminoacids,phosphates,sulphates.The proximal tubule is also able to secrete certain substances into the lumen for excretion inthe urine. It includes Hydrogen ions, Organic acids (e.g.Penicillins,thiazide),Organic bases (e.g.histamine,thiamine) and EDTA(Ethylene diamine tetraaceticacid)



ACID BASE AND ELECTROLYTE HOMEOSTASIS

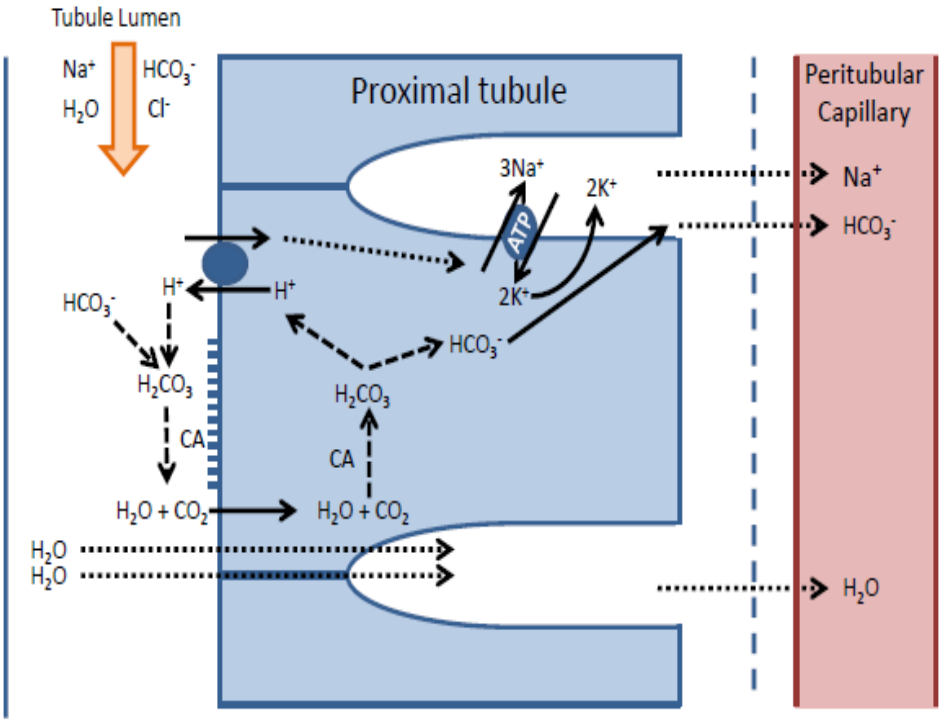
Sodium and Potassium :

All reabsorption in the proximal tubule can be considered to begin with the active transport of sodium out of the epithelial cells into the lateral spaces by Na+/K+ ATPases. These ATPases pump three Na+ ions out of the cell and two K+ ions into the cell. This lowers the intracellular Na+ concentration and gives the inside of the cell as light negative charge, thereby setting up concentration and electrochemical gradients for the facilitated diffusion of Na+ ions from the tubular lumen into the cells via specific carrier proteins. This movement of sodium ions can be coupled to the reabsorption of other solutes e.g. HCO_3^-, glucose and Cl-. Intracellular K+ concentration is much higher than extracellular fluid K+ concentration and cell membranes are permeable to K+. Therefore, the K+ that is pumped into the cell by the Na+/K+ ATPases simply diffuses back out again. The Na+ that accumulates in the lateral spaces then crosses the basement membrane and enters the peritubular capillary.



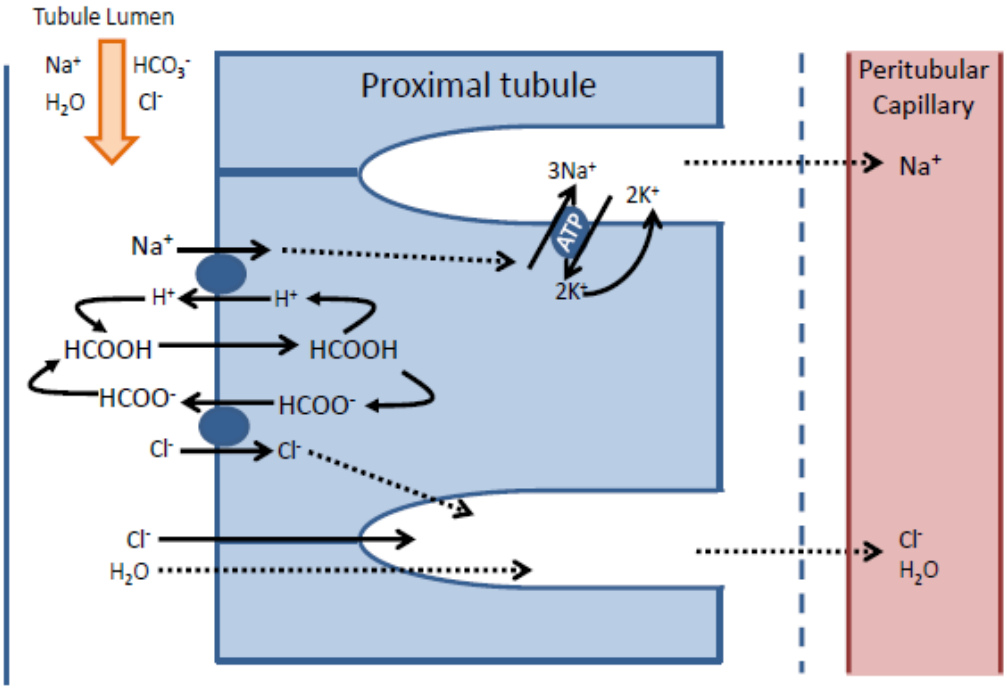
Bicarbonate :

Some of the carrier proteins that facilitate the diffusion of Na+ into the cells also transport H+ ions out of the cell, into the tubular lumen. In the lumen H+ ions combine with HCO_3- to form carbonic acid (H_2CO_3), which rapidly dissociates into carbon dioxide (CO_2) and water. This series of reactions is catalysed by the enzyme carbonic anhydrase (CA), found in abundance in the brush border of the epithelial cells. The CO_2 readily diffuses through the cell membrane into the epithelial cells where the reaction sequence is reversed leading to the formation of H+ (effectively this has been recycled) and HCO_3-. The concentration of HCO_3- within the cell increases, causing it to diffuse into the lateral spaces before entering the peri-tubular capillary. This allows the kidney to conserve the body's bicarbonate, mechanism by which the kidney plays a key role in the acid-base homeostasis of the body.



Chloride :

Chloride is reabsorbed in the proximal tubule in two ways. Firstly, an anti-port mechanism pumps organic anions(HCOOH) into the lumen in exchange for Cl- ions. The organic anions then combine with some of the H+ ions allowing them to be reabsorbed and recycled. Secondly, as Na+ and HCO_3- ions are rapidly reabsorbed early in the proximal tubule the concentration of Cl- ions left in the tubular fluid rises, setting up a concentration gradient for para-cellular diffusion of Cl- ions.



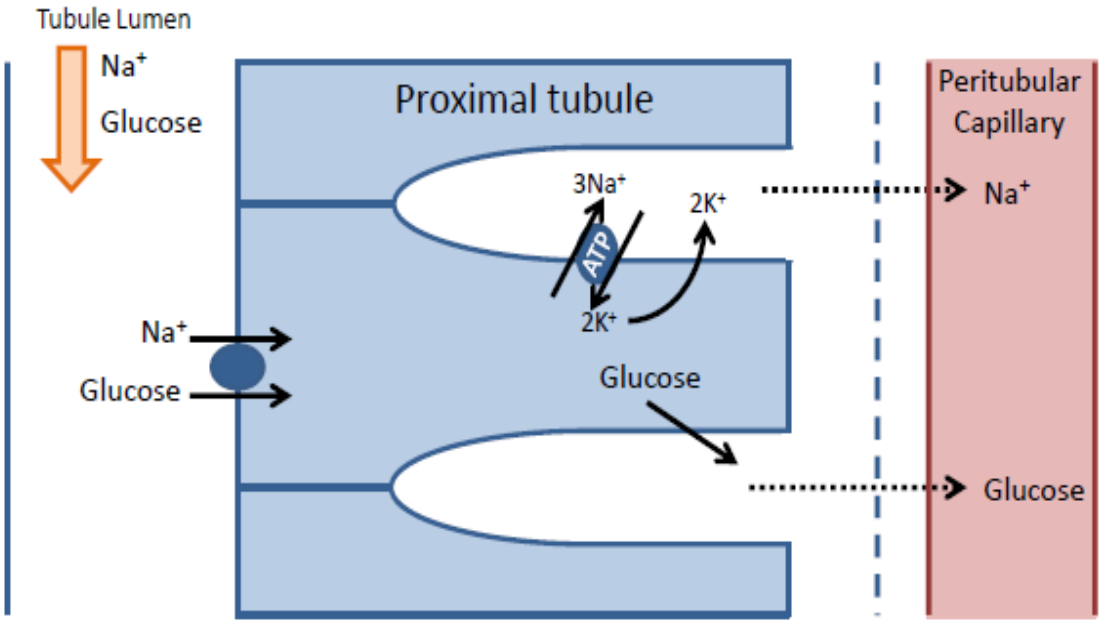
Water :

The epithelial cells lining the proximal tubule are very permeable to water molecules. Every solute ion that is reabsorbed from the tubular fluid into the lateral spaces will reduce the tonicity of the fluid that is left behind in the

lumen, and increase the tonicity in the lateral spaces. Water is thus reabsorbed by osmosis via both transcellular and para-cellular route.

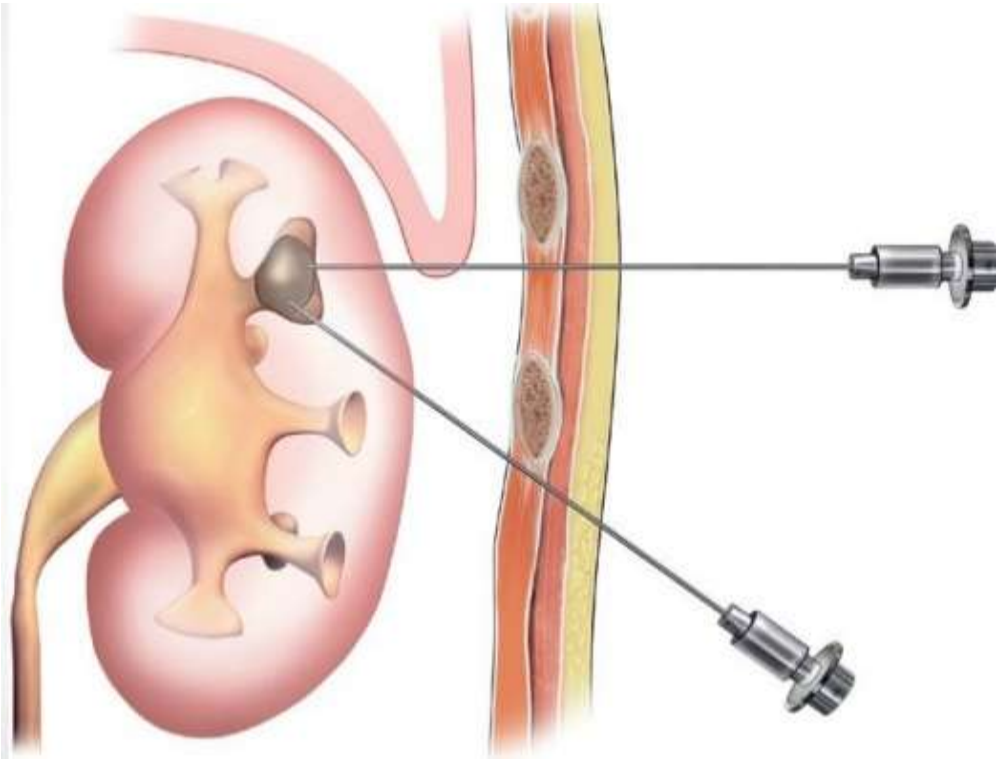
Glucose :

Glucose reabsorption is coupled to Na+ reabsorption. A gradient is established to allow Na+ reabsorption from the tubular fluid. There are glucose co-transporters (sodium glucose transporters, SGLTs) in the proximal tubule of nephron. These couple the movement of Na+ ions down their concentration gradient into the cells with the movement of glucose molecules against their concentration gradient into the cells. This is an example of secondary active transport.



PERCUTANEOUS NEPHROLITHOTOMY

Percutaneous nephrolithotomy, or PCNL, is a procedure for removing medium-sized or larger renal calculi (kidney stones) from the patient's urinary tract by means of an nephroscope passed into the kidney through a track created in the patient's lumbar region. PCNL was first performed in Sweden in 1973 as a less invasive alternative to open surgery on the kidneys. The term "percutaneous" means the procedure is done through the skin. Nephrolithotomy is a term formed from two Greek words that mean "kidney" and "removing stones by cutting." The purpose of PCNL is the removal of renal calculi in order to relieve pain, bleeding into or obstruction of the urinary tract, and/or urinary tract infections resulting from blockages. Kidney stones range in size from microscopic groups of crystals to objects as large as golf balls. Most calculi, however, pass through the urinary tract without causing problems.



Renal calculi are formed when the urine becomes supersaturated (overloaded) with mineral compounds that can form stones. This supersaturation may occur when the patient has low urinary output, excreting too much salt, or has very acidic urine. Urolithiasis refers to the formation of renal stones.

There are several different types of kidney stones, in terms of chemical composition:

- Calcium oxalate calculi: About 80% of calculi found in patients are formed from calcium combined with oxalate, which is a salt formed from oxalic acid. Some foods, such as rhubarb and spinach, are high in oxalic acid. Oxalic acid is also formed in the body when vitamin C is broken down. Oxalic acid is ordinarily excreted through the urine but may be absorbed in large amounts due to chronic pancreatic disease or surgery involving the small intestine.
- Uric acid calculi: These stones develop from crystals of uric acid that form in highly acidic urine. Uric acid calculi account for about 5% of kidney stones. In addition, some kidney stones are a combination of calcium oxalate and uric acid crystals.
- Cystine calculi: Cystine calculi represent about 2% of kidney stones. Cystine is an amino acid that may form hexagonal crystals in the urine when it is excreted in excessive amounts. Kidney stones made of cystine indicate that the patient has cystinuria, a hereditary condition in which the kidneys do not reabsorb this amino acid.
- Struvite calculi: Struvite is a hard crystalline form of magnesium

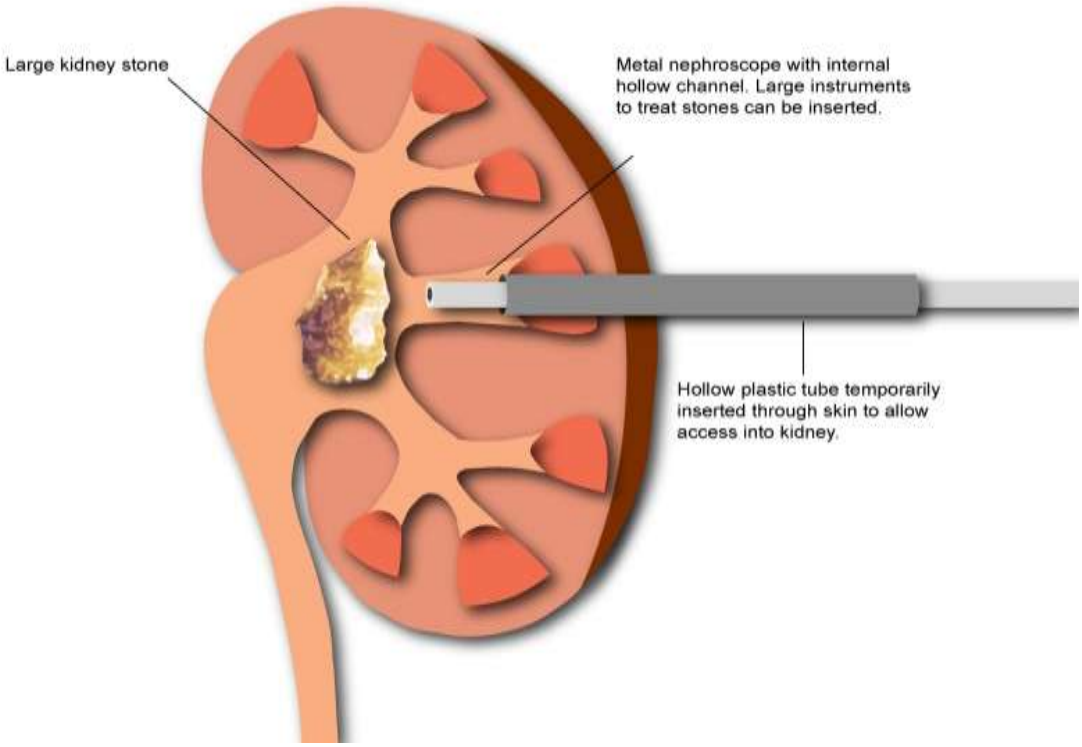
ammonium phosphate. Kidney stones made of this substance are formed in patients with urinary tract infections caused by certain types of bacteria. Struvite calculi are also known as infection calculi for this reason.

- Staghorn calculi: Staghorn calculi are large branched calculi composed of struvite. It is usually seen in patients having recurrent urinary tract infection with urease producing bacteria (Eg:Proteus, Klebsiella, Pseudomonas). Their size and shape complicate their removal from the urinary tract.

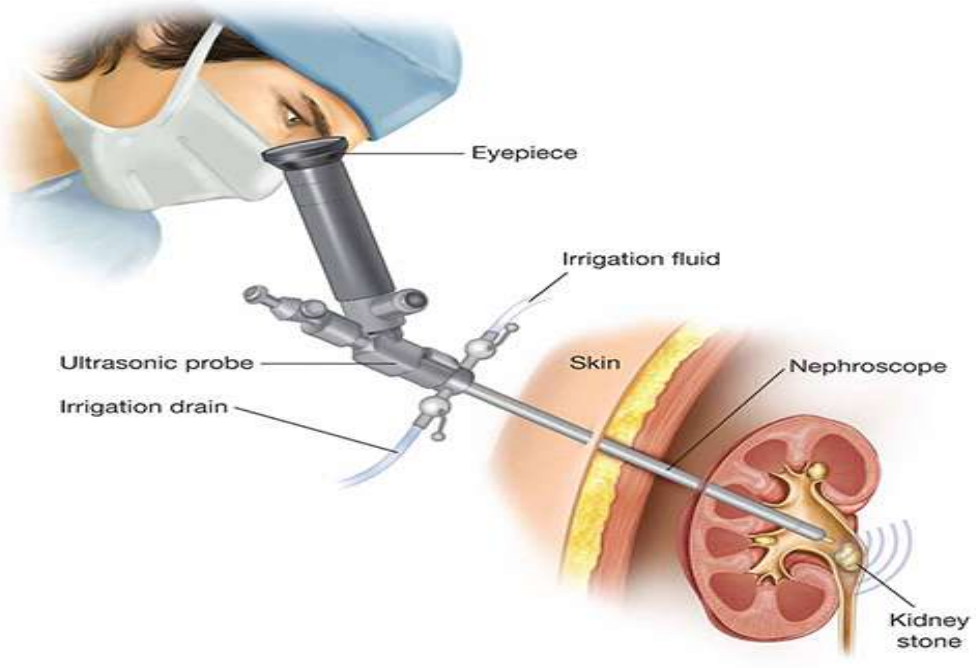
STANDARD PCNL

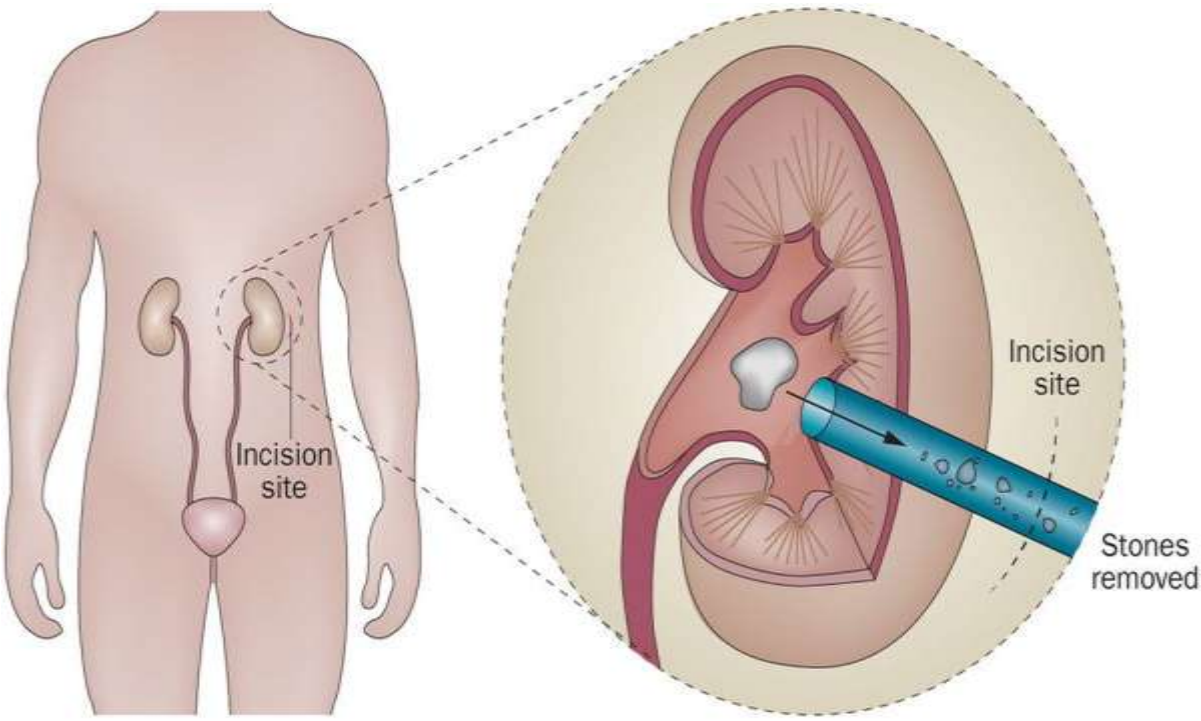
A standard percutaneous nephrolithotomy is performed under general anesthesia in the prone position. After the patient has been anesthetized, the surgeon makes a small incision, about 0.5 inches (1.3 cm) in length in the patient's back on the side overlying the affected kidney. The surgeon then creates a track from the skin surface into the kidney and enlarges the track using a series of Teflon dilators or bougies. A sheath is passed over the last dilator to hold the track open.

After the track has been enlarged, the surgeon inserts a nephroscope with a fiberoptic light source and two additional channels for viewing inside the kidney and irrigating the area. The surgeon may use a device with a basket on the end to grasp and remove smaller stones. Larger stones are broken up with an ultrasonic or electrohydraulic probe, or a holmium laser lithotriptor. The holmium laser has the advantage of being usable on all types of calculi.

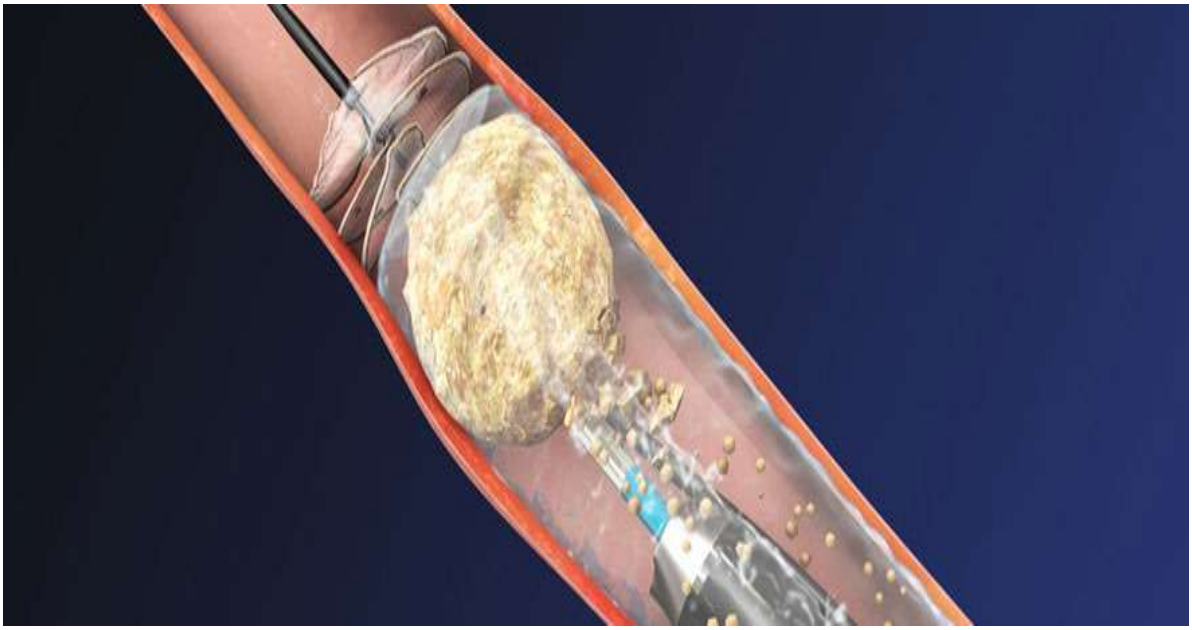


SURGICAL APPROACH





STONE REMOVAL



A catheter is placed to drain the urinary system through the bladder and a nephrostomy tube is placed in the incision in the back to carry fluid from the kidney into a drainage bag. The catheter is removed after 24 hours. The nephrostomy tube is usually removed before the patient is being discharged.

MINI-PERCUTANEOUS NEPHROLITHOTOMY

A newer form of PCNL is called mini-percutaneous nephrolithotomy (MPCNL) and it is performed with a miniaturized nephroscope. MPCNL has been found to be 99% effective in removing calculi between 0.4 and 1 inch (1 and 2.5 cm) in size. Although it cannot be used for larger kidney stones, MPCNL has the advantage of fewer complications, a shorter operating time (about one and a half hour), and a shorter recovery time for the patient.

IRRIGATION SOLUTION

Irrigation fluid is used in endoscopic urological surgeries for better vision, to wash away the stone fragments and blood clots. An ideal irrigating fluid should

- isotonic,
- non-hemolytic,
- non-toxic ,
- electrically inert,
- transparent and
- inexpensive.

Physiologic saline is the most commonly used fluid because it is isotonic and also compatible with interventions, unless electro-cautery is needed. When cautery is used, ion-free fluids such as glycine or distilled water are preferred. By the use of hypotonic solutions such as distilled water, the visibility would be improved; however, it can result in dangerous complications. In transurethral resection of the prostate (TURP), this manifestation is called TUR syndrome which includes cardiovascular, neurologic, electrolyte and metabolic derangements

The rate of TUR syndrome is related to the type of irrigating fluid, Operation time, patient position, prostate size, fluid bag height, surgeon experience, intraprostatic vasopressin injection. Severe hyponatremia can occur as a result of excess water load when mannitol or glycine is used for irrigation.

Absorption of irrigation fluid during PCNL has been associated with a Variety of significant complications. Common irrigation solutions includes

Glycine- Currently, the most commonly used irrigant is 1.5% glycine (osmolality:200). The liver metabolizes glycine into ammonia, water and glycolic acid, resulting in hyperammonemia. When large amounts of glycine are absorbed, hyperammonemia and water intoxication can lead to cerebral edema and seizures. Increased absorption can also cause hyper-oxaluria.

Normal Saline and lactated Ringer's solution conduct the electrical current but not the thermal properties of the diathermy. They cause dispersion of the electrical current, and no cutting or coagulation occurs. Electrolyte based solutions are therefore not used as an irrigating solution for TURP procedures.

Distilled Water- Water may be used for irrigation procedures, but it is hypotonic and eventually will result in hemolysis. When the blood cells break down during hemolysis, free serum hemoglobin and potassium are released. Although a free serum hemoglobin level is not toxic until it reaches 600 mg/dl, its combination with abnormal serum proteins, renders it nephrotoxic at lower levels. Additionally, the release of potassium can lead to hyperkalemia resulting in cardiac arrhythmias and muscular weakness. Severe hyponatremia and hypo-osmolality can occur, with CNS symptoms including convulsions and coma.

TUR SYNDROME

It is more common with the resection of prostrate. Also Hysteroscopy for transcervical resection of the endometrium or submucous myomectomy has been associated with symptoms like those of TURP syndrome.

The primary concern associated specifically with TURP is intravascular absorption of large volumes of irrigating fluid during the procedure. The absorption occurs predominantly through exposed venous sinuses of the surgical capsule. A spectrum of clinical and physiologic changes occurs. The clinical manifestations brought about by intravascular fluid absorption are referred to as the TURP syndrome, and the degree of symptoms depends on the type, magnitude and extent of absorbed fluid.

Transurethral resection syndrome is a constellation of symptoms and signs caused primarily by absorption of irrigating fluid. The features of the syndrome includes

1. CNS: disorientation, restlessness, confusion, agitation, drowsiness, convulsions, coma. Usually due to water intoxication, dilutional hyponatremia and hypo-osmolality occurs. Blindness, delayed recovery from anaesthesia, drowsiness may be due to glycine toxicity.
2. CVS: volume overload, dyspnea, pulmonary congestion, pulmonary edema, cardiac arrest. Due to fluid overload and negative inotropic effect of hyponatremia.

3. Hemolysis.

4. Hypothermia-The decrease in body temperature during the procedure is related to the temperature of the irrigating solution and the duration of the surgery. Several litres of irrigation solution used during the procedure can reduce body temperature at the rate of 1^{*} C per hour.

If the patient is under general anaesthesia, the presenting signs of TURP syndrome are typically a rise and then a fall in blood pressure, decreasing oxygen saturation, and severe refractory bradycardia. The ECG may show nodal rhythm, ST –segment changes, U waves, and widening of the QRS complex. Recovery from general anaesthesia is usually delayed.

Intra-vascular absorption of irrigating fluid can lead to Over-hydration. It was 1st described as a syndrome in 1973, when 1.2% glycine was used.

The syndrome of over-hydration consists of a triad of signs

a) Bradycardia.

b) Elevated systolic and diastolic BP with increased pulse pressure.

c) Cerebral agitation and depression.

Cerebral signs may be variable but generally commence with headache, dizziness, restlessness, agitation and confusion graduating to progressive obtundation, stupor and coma. Neuromuscular disturbances ranging from twitches to seizures can occur. Later dyspnoea, cyanosis, refractory hypotension and cardiac arrest may follow.

The absorption of large amounts of electrolyte free irrigating solution results in increased intra-vascular volume, haemo-dilution, hyponatremia and development of left heart failure, pulmonary and cerebral oedema and ultimately cardiovascular collapse. It is seen that faster the fall of serum sodium levels, more are the toxic symptoms likely to develop. A drop of 20-30meq/lit or an absolute value of 120meq/lit indicates a severe reaction.

In less florid cases, hypothermia, weight gain and post-operative diuresis is seen. When over-hydration syndrome is suspected, immediate measurement of Sr.Sodium and Sr.Osmolality should be done.Those patients with isolated alteration of sodium concentration may not develop serious sequelae and spontaneously diurese and need no further treatment.

When patient develops neurological signs, prompt intervention is required. Treatment is directed towards reversing the flow of water into the cells and correcting hypotonicity. Immediately surgery should be stopped, patient to be oxygenated and diuretic like Furosemide to be administered with restriction of fluid intake. Then correction of hyponatremia is best done by hypertonic saline in which case sodium requirement is calculated based on total body water. Aim should be to bring the sodium level >120 meq/lit. As administration of hypertonic saline is not without risk of fluid overload simultaneous Furosemide should be administered. Therapy should be monitored by assessing clinical and biochemical improvement.

MEASURES TO REDUCE TUR SYNDROME :

-The patient must be prepared properly for surgery. Preparation should include adequate hydration, electrolyte analysis, and coagulation profile.

-The most important step in minimizing the risk of TURP syndrome is to limit the duration of surgery

-The hydrostatic pressure created by the fluid irrigating the surgical site must be minimized. Because the irrigating fluid flows by gravity, the bag of irrigation should not hang higher than 60 cm above the operative field.

-Careful surgical resection minimizes exposure of the venous sinuses

-Blood pressure must be stable. A decrease in pressure lowers the venous pressure and allows increased absorption of fluid

PRONE POSITION IN ANAESTHESIA

Prone positioning of patients during anaesthesia is required to provide good operative access for a wide variety of surgical procedures. Common procedures requiring prone positioning are spine surgeries, percutaneous nephrolithotomy, posterior fossa tumours, pilonoidal sinus surgery and few types of ankle surgery e.g. Achilles tendon repair. It is associated with predictable changes in physiology but also with a number of complications, and safe use of the prone position is essential to overcome the complications.

Cardiovascular system :

The most important feature of prone position under anaesthesia is decrease in cardiac output. Cardiac index decreases by an average of 24%. This was due to decreasing stroke volume with little change in heart rate. Decreased preload was due to reduced cardiac output due to IVC compression. Adequate padding, proper positioning of the abdomen without compression and minimal head down can reduce this complication.

Respiratory system :

Functional residual capacity and arterial oxygen tension both increase. So prone positioning has been used in intensive care settings for patients with poor lung function – often secondary to acute lung injury. Due to changes in ventilation and perfusion it results in better V/Q matching and improved arterial oxygen tension.

Pressure injuries:

Dependent areas must be carefully noted and protected – these include the forehead, nose, chest, arms, breasts and genitalia, pelvis (superior iliac spines), knees and feet. Pressure injury can be by direct pressure, or by occlusion to an arterial supply or venous drainage.

Ocular damage:

Ocular damage is caused by two mechanisms. First is direct pressure to the eyes - incorrect positioning leading to the weight of the head being supported by the globe will intuitively result in damage, secondary to ischaemia. The second is a result of poor perfusion. Occlusion to the venous drainage, or any generalised rise in venous pressure will raise the IOP, as will use of a head-down position. MAP may be reduced either by deliberate hypotension or abdominal compression. If ocular perfusion pressure is too low to adequately perfuse the eyes then ischaemic damage will result.

REVIEW OF LITERATURE

1. MOHAMMAD MEHDI HOSSEINI[23], ABBAS HASSANPOUR, FARHAD MANAHEJI(2014) conducted study published in urol J Vol.11, No.3,1551. To compare dilutional effect of distilled water with saline solution as an irrigation fluid in percutaneous nephrolithotomy. Three hundred twenty eight adult patients were randomly assigned into two groups (group 1- distilled water, group 2- saline solution). Stone size, operation time, irrigation fluid volume, blood haemoglobin level, urea nitrogen, creatinine, sodium and potassium levels were checked before and at 6 and 12 hours after operation. Serum sodium concentrations remained within normal limits in all cases, without causing clinical signs and symptoms of hyponatremia and they concluded that distilled water is safe irrigation fluid for PCNL in adults.

2. AKASH GUPTA[3], RAVI PRAKASH, VINITA SINGH,JAISHREE BOGRA conducted a Comparative study of electrolytes and metabolic changes during percutaneous nephrolithotomy- spinal vs. general anaesthesia published in Gupta A et al. Int J Clin Trials. 2014,41-48.It is a randomized, prospective, study conducted on 60 patients, aged between 25 to 60 years belonging to ASA PS I or II undergoing PCNL. In this study they measured blood pH, serum lactate and bicarbonate levels as metabolic variables to assess the metabolic acidosis associated with irrigation, hypoperfusion and renal dysfunction. Difference in pH and bicarbonate levels of both the groups was statistically non-

significant at pre-op and intraop period but changes in bicarbonate and base excess, had a significant fall in postoperative period. Study shows decrease in bicarbonate with the increase in duration of irrigation with tendency to metabolic acidosis.

3. VAHIT GUZELBURC[29],MEHMET BALASAR,MUKADDES COLAKO GULLARI,SELCUK GUVEN,(2016)Comparison of absorbed irrigation fluid volumes during retrograde intrarenal surgery and percutaneous nephrolithotomy A total of 60 patients were included the study.Fluid absorption occurred in all patients. Minimum and maximum ranges of fluid absorption were recorded during the procedure. The increase in fluid absorbed volume was observed as a result of the given amount of irrigating fluid used in the PCNL group. Also prolongation of operation led to a significant increase in absorption in the PCNL group.No patients developed post-operative electrolyte imbalance.

4.BIMALESH PURKAIT[7], MANOJ KUMAR, ANKUR BANSAL, published inTurk J Urol 2016; 42(3): 267-71.They evaluated the outcomes of normal saline as irrigation solutionin renal failure patient in comparison to distilled water. Seventy-six patients with renal calculi were enrolled in this study. All patients wererandomized into two groups as Group A (normal saline irrigation), and Group B (distilled water irrigation).Serum electrolytes, hemogram were measured pre- and post operatively. Distilled water is associated with hyponatremia and drop in hematocrit level in renal failure patients. Serum potassium level may be significantly altered during distilled

water irrigation. Normal salineis safe for PNCL in renal failure patient and its use should be recommended for this purpose..

5. HOSEIN KHOSHRANG[15], SIAVASH FALAHATKAR, SARA ILAT, MANZAR HOSSEIN AKBAR, MARYAM SHAKIBA :Nephrourol. 2012; 622–628.They did a Comparative study of hemodynamics,electrolyte and metabolic changes during prone and complete supine percutaneous nephrolithotomy in 40 ASA class I and II patients. Blood pressure (systolic, diastolic and mean) and pulse rate were recorded before, during and after anesthesia and Hb, Hct, BUN, Cr, Na, and K were also measured before and after operation in the two groups. The volume of **irrigate** on fluid, total effluent fluid (the fluid in the bucket and the gazes) and volume of absorbed fluid were measured. **R**esults concluded that electrolyte and metabolic changes were not significantly different between the two groups, and fluid absorption in prone group was more than that of the complete supine group, with no significant difference between the two groups.

6.YI-SHAO[30],ZHI JIE SHEN,YI-YANG ZHU conducted a study based on Fluid-electrolyte and renal pelvic pressure changes during ureteroscopic lithotripsypublished in July 2011.The objective of the study was to evaluate fluid-electrolyte and renal pelvic pressure (RPP) changes during ureteroscopic lithotripsy. Fluid-electrolyte and renal pelvic pressure changes during ureteroscopic lithotripsy. Haemoglobin (Hb), haematocrit (Hct), blood urea nitrogen (BUN), creatinine (Cre), serum sodium (Na(+)), potassium (K(+)), chlorine (Cl(-)) were recorded before and after ureteroscopic lithotripsy.There were no significant changes in fluid-electrolyte. RPP was significantly increased

during ureteroscopic lithotripsy, it was correlated with the irrigation pressure and the position in the ureter.

7.MEDHA MOHTA [22], TARUN BHAGCHANDANI, ASHA TYAGI, MILAN PENDSE, A. K. SETHI IntUrolNephrol (2008) 40:477–482. Haemodynamic, electrolyte and metabolic changes during Percutaneous nephrolithotomy were recorded in 20 patients . Heart rate, systolic and diastolic blood pressure, arterial blood gases, electrolytes and temperature were monitored before, during and after irrigation. Haemoglobin, urea and creatinine values were recorded before and 24 h after the procedure. Durations of anaesthesia and irrigation, volumes of irrigation fluid used and effluent fluid were recorded. No significant changes occurred in haemodynamics and electrolytes, but there was a trend towards metabolic acidosis.

8.FEIZZADEH B[10], DOOSTI H, MOVARREKH M published a study on Distilled water as an irrigation fluid in percutaneous nephrolithotomyin urol j. 2006 fall;3(4):208-11.Total of 30 patients with renal calculi underwent tubeless PCNL using distilled water as the irrigation fluid. During the procedure, intravenous Ringer lactate solution was used if necessary. The patients received infusion of two-thirds dextrose 5% and one-third normal saline solution postoperatively. Four blood samples were taken to determine serum sodium and potassium levels at admission, just before the operation, after the operation, and on the first postoperative day. Using distilled water as an irrigation fluid during PCNL does not result in a clinically significant decrease

in the serum level of sodium .

9. KOROGLU A[16], TOGAL T, CICEK M ET AL (2003) The effects of irrigation fluid volume and irrigation time on fluid electrolyte balance and hemodynamics in percutaneous nephrolithotripsy. IntUrolNephrol 35:1. Study done to determine fluid-electrolyte and hemodynamics changes and complications associated with irrigation fluid volume and duration time in percutaneous nephrolithotripsy with 0.9% NaCl for irrigation. Mean arterial pressure, heart rate, central venous pressure, Na+, K+, osmolality, haemoglobin, haematocrit were recorded before, during and after irrigation every 10 minutes. The operation and irrigation times, irrigation fluid volume, total fluid output versus input, blood transfusions and complications were recorded. There were no significant changes in fluid-electrolyte balance and hemodynamics related to both irrigation volume and duration of irrigation when 0.9% NaCl was used in Percutaneous nephrolithotomy.

10.KUKREJA RA[17], DESAI MR, SABNIS RB, PATEL SH, conducted study on Fluid absorption during percutaneous nephrolithotomy published in J Endo urol. 2002 May;16(4):221-4. This study evaluated the presence of fluid absorption during PCNL, its clinical and biochemical significance, and maneuvers to reduce it in 148 patients by estimating the expired breath ethanol concentration. Fluid absorption during PCNL may be clinically significant in patients with compromised cardiorespiratory or renal status and in paediatric patients, leading to fluid overload. Reducing the nephroscopy time and the amount of irrigating fluid used, and staging the procedure for large renal stone burdens, especially in the presence of perforation of the pelvicaliceal system,

reduces fluid absorption and avoids volume overload.

11. ATICI S[1], ZEREN S, ARIBOĞAN A. Conducted a study on Hormonal and hemodynamic changes during percutaneous nephrolithotomy published in Int Urol Nephrol. 2001;32(3):311-4. Twenty-one patients between 15–65 years of age were included in the study. Invasive blood pressure and heart rate were monitored during PCNL. Serum sodium, potassium, BUN and creatinine levels were measured before and after the surgery. Sodium and potassium levels were also measured during the operation. Arterial blood gases, renin, aldosterone and adrenocorticotrophic hormone (ACTH) levels were measured before and during irrigation. Serum sodium, potassium , bicarbonate and base-excess levels were decreased during the surgery when compared to baseline. BUN and creatinine levels remained unchanged during the study. The study concluded that there is a tendency towards hyponatremia and metabolic acidosis developed in addition to significant increases in renin, aldosterone and ACTH levels during PCNL .

12.GEHRING H[12], NAHM W, ZIMMERMANN K, FORNARA P, OCKLITZ , SCHMUCKER published study in ActaAnaesthesiol Scand. 1999 Mar; 43(3) :316-21 .Irrigating fluid absorption during percutaneous nephrolithotripsy. They compared groups with intravascular Vs extravascular absorption.
In a prospective study of 31 patients with PNCL, ethanol was added to the irrigating fluid and blood ethanol concentration (BEC) was measured by gas chromatography during the endoscopic procedure and in the recovery room.

Retroperitoneal extravasation identified by using ethanol monitoring during and after PNL. Extravascular absorption could be differentiated from intravascular absorption due to their unique absorption characteristics, and that these characteristics enable a prediction of possible post-operative complications. Afflicted patients require considerably longer hospitalisation. However, electrolyte values before irrigation and at discharge from the recovery room in individual groups were also not found to be different.

MATERIALS AND METHODS

STUDY DESIGN:

A Prospective study.

STUDY POPULATION:

40 patients

PATIENT SELECTION:

After getting the approval of the institutional ethics committee, Patients undergoing PCNL surgery done in urology OT will be assessed for inclusion and exclusion criteria and will be included in the study after obtaining written informed consent .

DURATION OF THE STUDY: **6 months**

Sample Size was determined based on

Study

Haemodynamic,electrolyte and metabolic changes during percutaneous nephrolithotomy

Authored by

Medha Mohta et al

Published in

Int Urol Nephrol (2008) 40:477–482

In this study, there was a significant fall in mean pH in postoperative period (P = 0.003) (0.81% decrease)

Description

- The confidence level is estimated at 95%
- with a z value of 1.96
- the confidence interval or margin of error is estimated at +/- 4
- Assuming p% =0.81% and q%=99.19%

  $n = p\% \times q\% \times [z/e\%]^2$

  $n = 0.81 \times 99.19 \times [1.96/4]^2$

  n= 19.29 (Rounded of to 19)

Therefore 19 is the minimum sample size required for the study to obtain a fall in mean pH in postoperative period between 0.78-0.84 %

(pH drop between 0.058-0.062)

In my study I plan to recruit a minimum of 40 patients.

Inclusion Criteria

- ASA Gr.I& II
- Age 18 to 60 years
- Patients undergoing elective PCNL
- Who have given valid informed consent

Exclusion Criteria

- ASA Gr.III& IV
- Patients with electrolyte imbalance or acid base disturbances
- Patients with deranged renal function
- Pregnant or lactating females

- ❖ Patients on any drug known to affect electrolytes
- ❖ Patients who had not given informed consent.

Materials

Monitors: ECG, NIBP, SPO_2, $EtCO_2$

18G Venflon

Drugs: Inj.Glycopyrrolate,Fentanyl, Midazolam, Thiopentone, Atracurium, Sevoflurane and Other Emergency Drugs, Normal Saline.

Study Outcome Measures

- ❖ Serum Sodium, Potassium, Chloride, pH & Bicarbonate values were recorded in Preoperative (baseline), Intraoperative (30 mins after irrigation) and in Postoperative periods.
- ❖ To correlate the above electrolyte and metabolic changes with duration of irrigation and volume of irrigation fluid infused.
- ❖ To compare preoperative and postoperative Haemoglobin levels.

METHODOLOGY

Ethics Committee Approval

↓

Patient Satisfying Inclusion Criteria

↓

Informed Consent Obtained

↓

Baseline Sr.Na^+, K^+, Cl^-, pH and HCO_3^- were recorded

↓

In OT Monitors Attached

↓

Baseline HR, BP, SPO_2 recorded

↓

Premedication

↓

Preoxygenation

↓

Induction

↓

Intubation with endotracheal tube

↓

Surgery proceeded with maintenance of anaesthesia and vital parameters monitoring

↓

Sr.Na^+, K^+, Cl^-, pH and HCo_3^- were recorded 30 Mins after irrigation

↓

End of surgery (Duration of irrigation and volume of irrigation fluid infused were recorded)

↓

Reversed and extubated

↓

Sr.Na^{+}, K^{+}, Cl^{-}, pH and HCo_3^{-} were recorded postoperatively

↓

Data Compilation

↓

Statistical Analysis

↓

Conclusion

METHODS

- After getting ethical committee clearance, 40 patients were enrolled for the study over a period of six months based on inclusion and exclusion criteria. Preoperative assessment, investigations and evaluation were done. Informed consent obtained from the patients.
- Baseline parameters like pH,bicarbonate, serum sodium, potassium, chlorideand haemoglobin were recorded.
- Patient was shifted inside the operating room and connected to monitors.
- Baseline vital parameters including HR, NIBP, SPO_2 were recorded.
- Procedure was done under general anaesthesia. Patient was premedicated withinj.glycopyrrolate 10 mcg/kg and inj.fentanyl 2 mcg/kg. Patient was preoxygenated with 100% oxygen for 3 minutes. Patient was induced intravenously with Inj.Thiopentone 5 mg/kg followed by intubation with the use of non-depolarising muscle relaxant Inj.Atracurium 0.5 mg/kg. Intubation done with appropriate size ETT tube and anaesthesia maintained with N2O:O2 mixture50:50% , sevoflurane and maintanence doses of Inj.Atracurium.
- Patient was placed in modified lithotomy position, a 5-French open tip ureteric catheter was inserted by using 19-ch. cystoscopy.
- Patient was turned into prone position and PCNL procedure was started.

Under fluoroscopic guidance, renal punctures done. The tract was dilated by semi rigid dilators and working sheath was placed.

- Fragmentation and extraction of stones was performed by a rigid nephroscope passed through this sheath.

- Intraoperative monitoring includes HR, NIBP, SPO2, EtCO2 and the amount of irrigation fluid used and the duration of irrigation.
- Intraoperatively Serum sodium, potassium, chloride , bicarbonate alongwith pH was measured using arterial blood sample if the duration of irrigation exceeds 30 minutes.
- At the end of the procedure duration of irrigation and the amount of irrigation fluid infused were noted.
- A22-ch. Drainage nephrostomy tube and ureteric catheter were routinely left for 48 hrs after PCNL.
- Once the procedure was completed, patient turned into supine position

with all precautionary measures. Later followed by administration of reversal agents (Inj.Neostigmine 50 mcg/kg and Inj.Glyco 10 mcg/kg) and patient was extubated after adequate neuromuscular recovery and thorough oropharyngeal suctioning.

- Serum sodium, potasium, chloride, bicarbonate, pH along with Haemoglobin were again recorded using arterial blood sample in post-operative room.
- After complete recovery, patient was shifted to postoperative ward.
- The collected data was compiled and statistical analysis was done.
- Complications associated with PCNL include acute loss of kidney function, TUR syndrome, colon injury, hydrothorax, perforation, pneumothorax, prolonged leak, sepsis, ureteral stone, and vascular injury. None of these complications was reported in our patients.

Groups

Study Periods	Definition	Study Subjects	Number
Pre-operative	Baseline	Patients undergoing PCNL procedures using Normal Saline as irrigation solution	40
Intra-operative	30 minutes after irrigation		
Post-operative	End line		

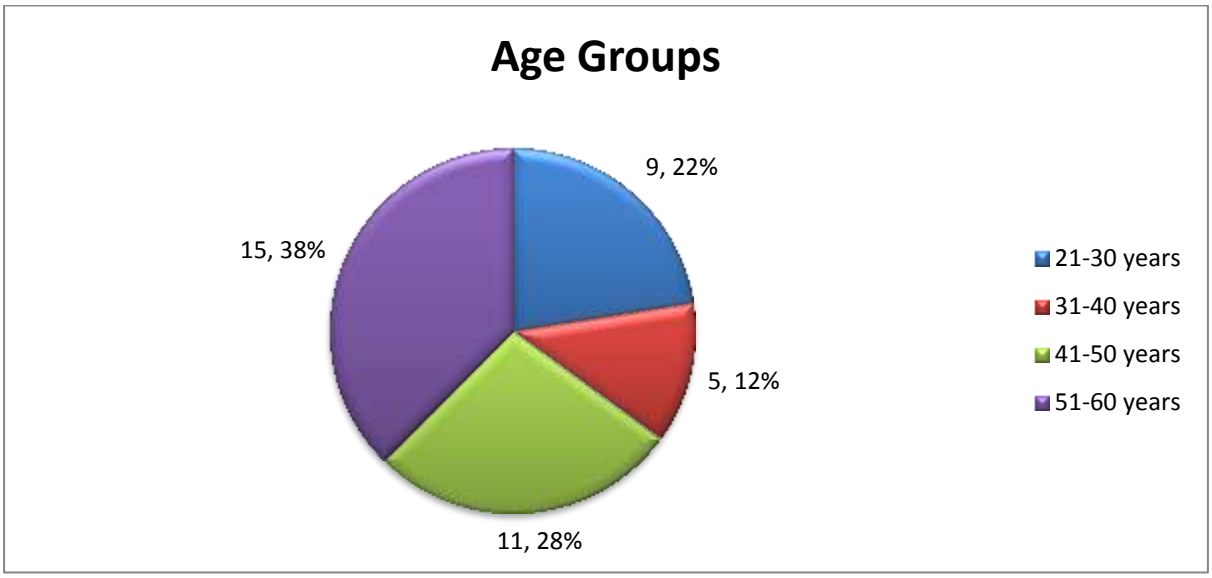
Null Hypothesis

Null Hypothesis : H0	There is no effect on electrolyte and metabolic changes occurring in Patients undergoing PCNL procedures using Normal Saline as irrigation solution during the study periods
Alternate Hypothesis : H1	There is an effect(>or<) on electrolyte and metabolic changes occurring in Patients undergoing PCNL procedures using Normal Saline as irrigation solution during the study periods

DATA ANALYSIS

Descriptive statistics was done for all data and were reported in terms of mean values and percentages. Suitable statistical tests of comparison were done. Continuous variables were analysed with the paired t test and ANOVA Two Factor without Replication Test. Categorical variables were analysed with the Chi-Square Test and Fisher Exact Test. correlation analysis was done using pearsons “r”. Statistical significance was taken as $P < 0.05$. The data was analysed using SPSS version 16 and Microsoft Excel 2007.

Age

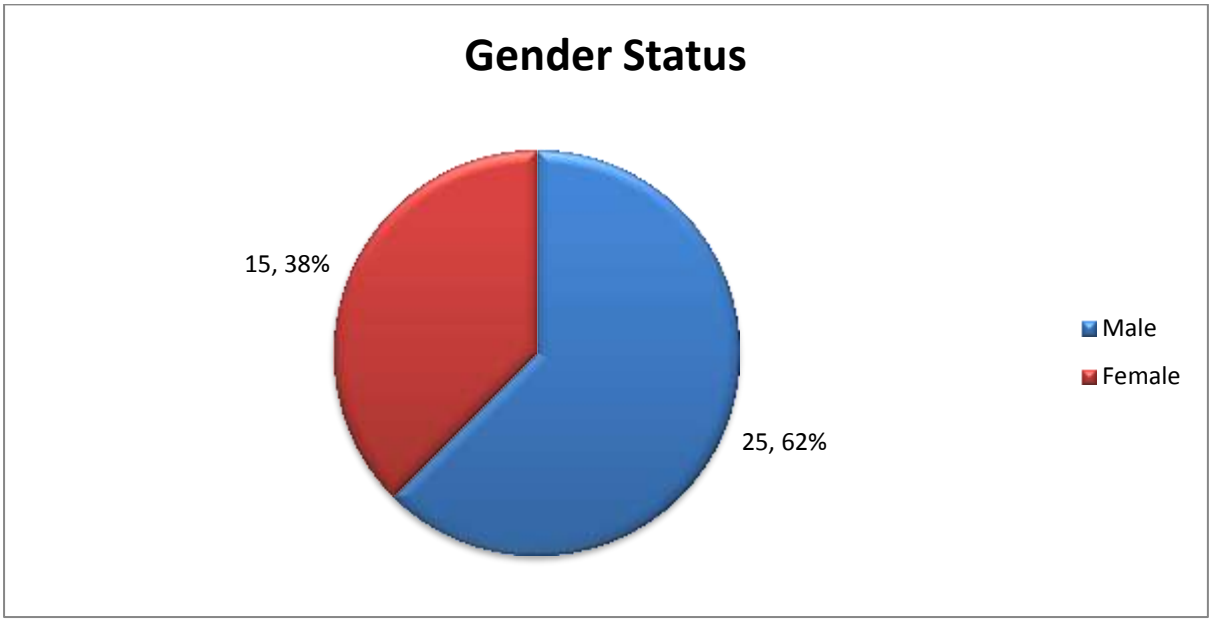


Age Groups	Number of Observations	%
21-30 years	9	22.50
31-40 years	5	12.50
41-50 years	11	27.50
51-60 years	15	37.50
Total	40	100.00

Age Distribution	Values
Mean	43.75
SD	12.20

On analyzing age distribution, most of the study subjects (n=15, 37.50%) were clustered in the 51-60 years age group followed by 41-50 years age group (n=11, 27.50%) . The mean age was 43.75years.

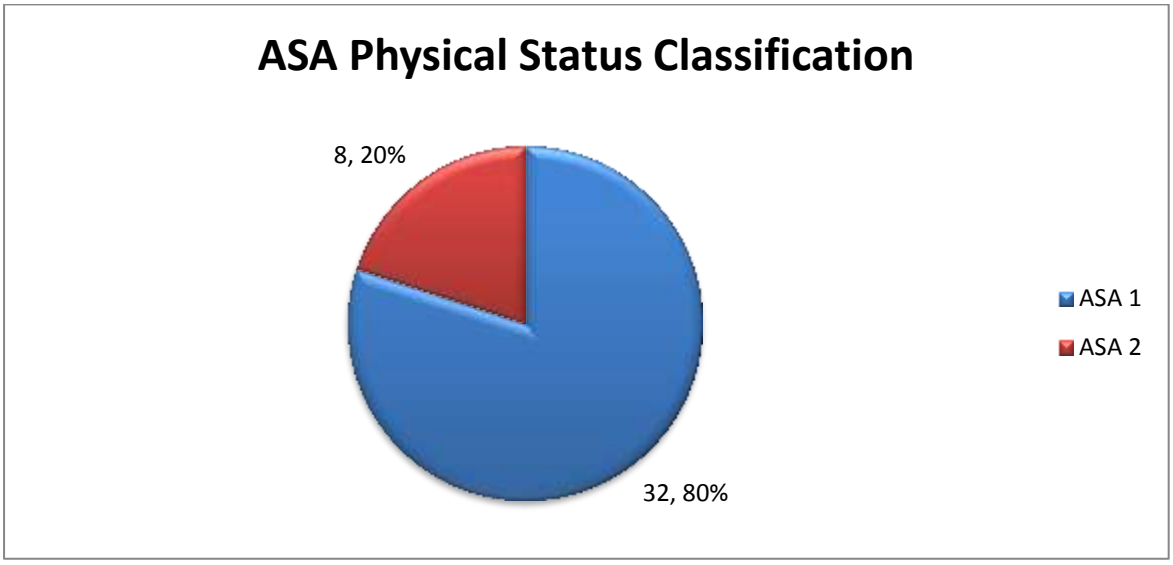
Gender



Gender Status	Number of Observations	%
Male	25	62.50
Female	15	37.50
Total	40	100.00

When gender status was examined, most of the study subjects (n=25, 62.50%) were males followed by females (n=15, 37.50%).

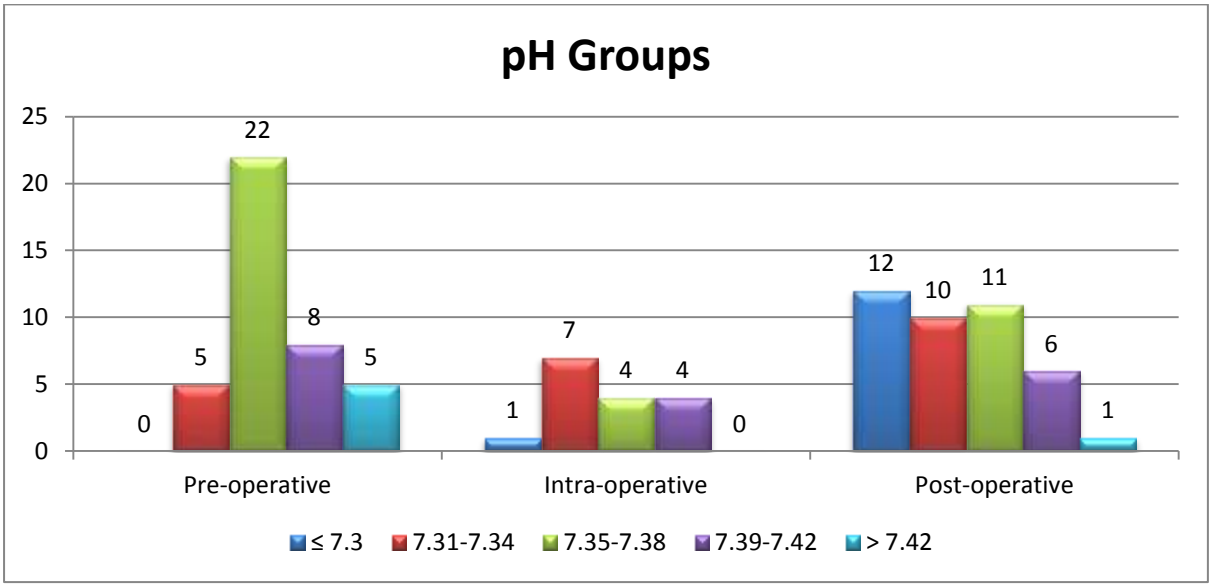
ASA PS



ASA Physical Status Classification	Number of Observations	%
ASA 1	32	80.00
ASA 2	8	20.00
Total	40	100.00

When ASA status was explored, most of the study subjects (n=32, 80.00%) were under ASA 1 status followed by ASA 2 status (n=8, 20.00%).

pH



pH Groups	Pre-operative	Intra-operative	Post-operative	Pre-operative (%)	Intra-operative (%)	Post-operative (%)
≤ 7.3	0	1	12	0.00	6.25	30.00
7.31-7.34	5	7	10	12.50	43.75	25.00
7.35-7.38	22	4	11	55.00	25.00	27.50
7.39-7.42	8	4	6	20.00	25.00	15.00
> 7.42	5	0	1	12.50	0.00	2.50
Total	40	16	40	100.00	100.00	100.00

pH Distribution	Pre-operative	Intra-operative	Post-operative
Mean	7.38	7.35	7.33
SD	0.03	0.02	0.05
P value Paired t Test	Pre-operative Vs Intra-operative		<0.0001
	Intra-operative Vs Post-operative		0.0330
	Pre-operative Vs Post-operative		<0.0001
P value ANOVA Two Factor Without Replication Test	<0.0001		

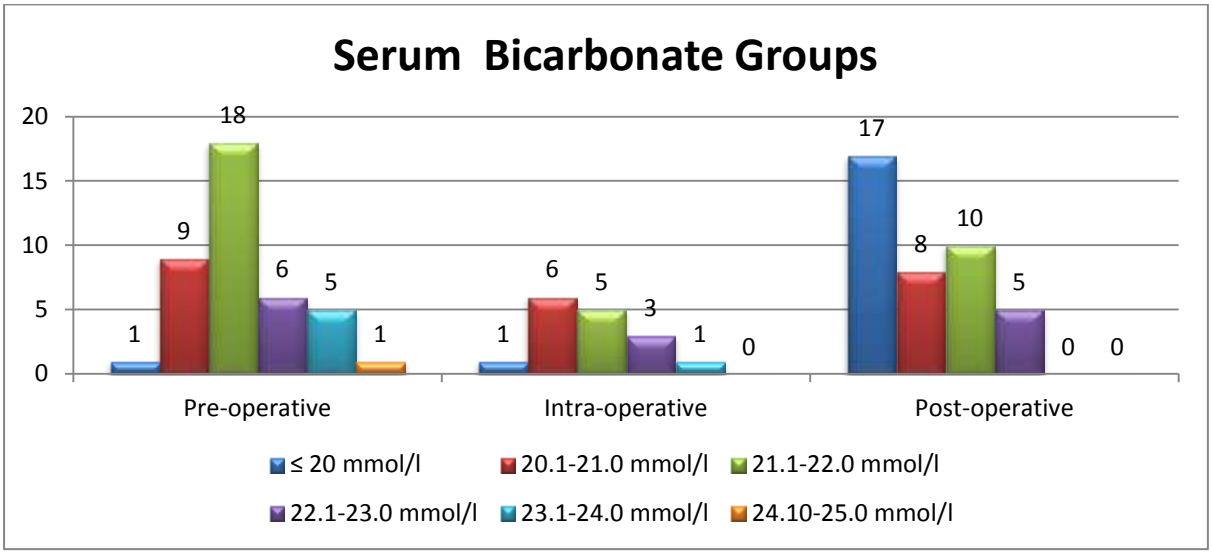
Among the study patients, there was a statistically significant difference in relation to pH distribution between the pre-operative (mean-7.38, SD-0.03), intra-operative (mean-7.35, SD-0.02) and post-operative (mean-7.33, SD-0.05) periods with a p value of <0.05 as per ANOVA two factor without replication test. Therefore we reject the null hypothesis that there is no difference in pH levels distribution between the study periods.

Conclusion

In this study we can safely conclude that there is a sustained decrease of pH levels among study subjects from pre-operative to post-operative stage.

This indicates that when normal saline is used as irrigation solution in percutaneous nephrolithotomy, there is a tendency for development of metabolic acidosis.

Bicarbonate



Serum Bicarbonate Groups in mmol/l	Pre-operative	Intra-operative	Post-operative	Pre-operative (%)	Intra-operative (%)	Post-operative (%)
≤ 20	1	1	17	2.50	6.25	42.50
20.1-21.0	9	6	8	22.50	37.50	20.00
21.1-22.0	18	5	10	45.00	31.25	25.00
22.1-23.0	6	3	5	15.00	18.75	12.50
23.1-24.0	5	1	0	12.50	6.25	0.00
24.1-25.0	1	0	0	2.50	0.00	0.00
Total	40	16	40	100.00	100.00	100.00

Serum Bicarbonate Distribution	Pre-operative	Intra-operative	Post-operative
Mean	21.75	21.22	20.43
SD	1.05	0.65	1.26
P value Paired t Test	Pre-operative Vs Intra-operative		0.0002
	Intra-operative Vs Post-operative		0.0001
	Pre-operative Vs Post-operative		<0.0001
P value ANOVA Two Factor Without Replication Test	<0.0001		

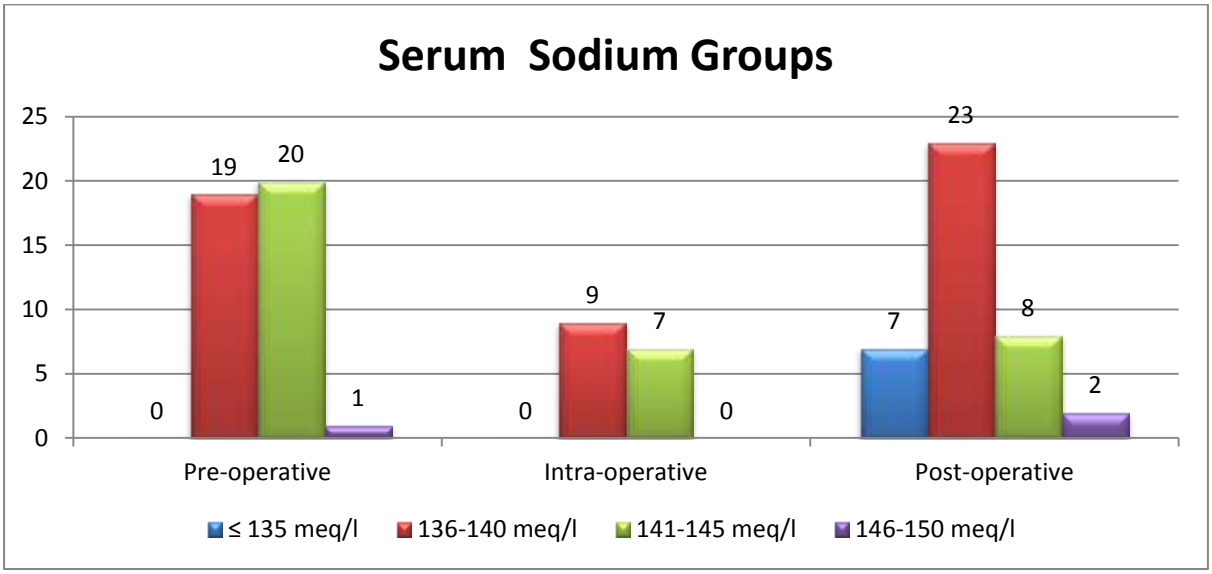
Among the study patients, there was a statistically significant difference in relation to sodium bicarbonate distribution between the pre-operative (mean-21.75, SD-1.05), intra-operative (mean-21.22, SD-0.65) and post-operative (mean-20.43, SD-1.26) periods with a p value of <0.05 as per ANOVA two factor without replication test. Therefore we reject the null hypothesis that there is no difference in sodium bicarbonate levels distribution between the study periods.

Conclusion

In this study we can safely conclude that there is a sustained decrease of sodium bicarbonate levels among study subjects from pre-operative to post-operative stage.

This indicates that when normal saline is used as irrigation solution in percutaneous nephrolithotomy, there is a tendency for development of metabolic acidosis.

Sodium



Serum Sodium Groups	Pre-operative	Intra-operative	Post-operative	Pre-operative (%)	Intra-operative (%)	Post-operative (%)
≤ 135 meq/l	0	0	7	0.00	0.00	17.50
136-140 meq/l	19	9	23	47.50	56.25	57.50
141-145 meq/l	20	7	8	50.00	43.75	20.00
146-150 meq/l	1	0	2	2.50	0.00	5.00
Total	40	16	40	100.00	100.00	100.00

Serum Sodium Distribution	Pre-operative	Intra-operative	Post-operative
Mean	140.60	141.00	138.85
SD	3.03	1.28	3.26
P value Paired t Test	Pre-operative Vs Intra-operative		0.3937
	Intra-operative Vs Post-operative		0.0001
	Pre-operative Vs Post-operative		0.0104
P value ANOVA Two Factor Without Replication Test	0.0001		

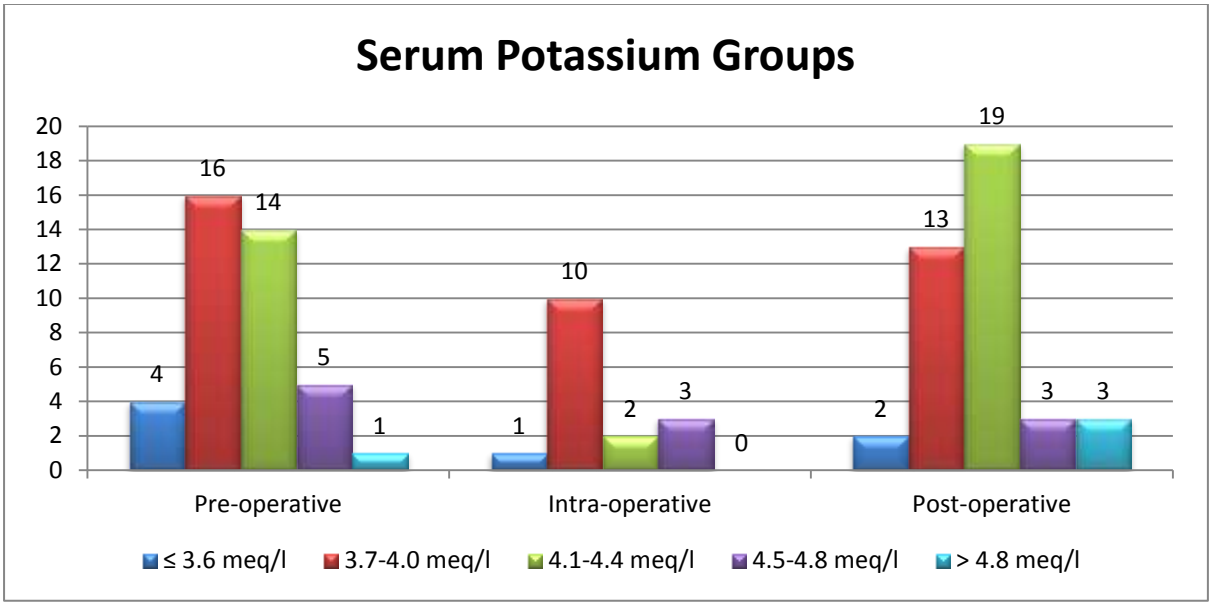
Among the study patients, there was a statistically significant difference in relation to serum sodium distribution between the pre-operative (mean-140.60, SD-3.03), intra-operative (mean-141.00, SD-1.28) and post-operative (mean-138.85, SD-3.26) periods with a p value of <0.05 as per ANOVA two factor without replication test. Therefore we reject the null hypothesis that there is no difference in serum sodium levels distribution between the study periods.

Conclusion

In this study we can safely conclude that there is a sustained decrease of serum sodium levels among study subjects from intra-operative to post-operative stage.

This indicates that when normal saline is used as irrigation solution in percutaneous nephrolithotomy, there is a tendency for development of hyponatremia post-operatively.

Potassium

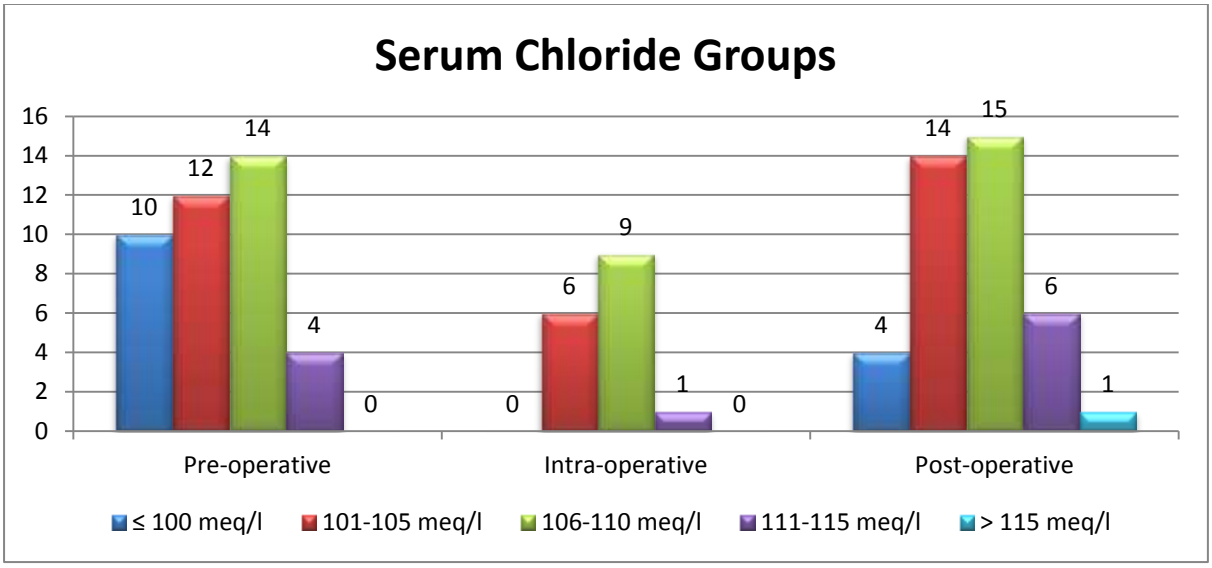


Serum Potassium Groups	Pre-operative	Intra-operative	Post-operative	Pre-operative (%)	Intra-operative (%)	Post-operative (%)
≤ 3.6 meq/l	4	1	2	10.00	6.25	5.00
3.7-4.0 meq/l	16	10	13	40.00	62.50	32.50
4.1-4.4 meq/l	14	2	19	35.00	12.50	47.50
4.5-4.8 meq/l	5	3	3	12.50	18.75	7.50
> 4.8 meq/l	1	0	3	2.50	0.00	7.50
Total	40	16	40	100.00	100.00	100.00

Serum Potassium Distribution	Pre-operative	Intra-operative	Post-operative
Mean	4.08	4.06	4.14
SD	0.34	0.20	0.33
P value Paired t Test	Pre-operativeVsIntra-operative		0.6843
	Intra-operativeVsPost-operative		0.0964
	Pre-operativeVsPost-operative		0.1956
P value ANOVA Two Factor Without Replication Test	0.0964		

Among the study patients, there was no statistically significant difference in relation to serum potassium distribution between the pre-operative (mean-4.08, SD-0.34), intra-operative (mean-4.04, SD-0.20) and post-operative (mean-4.34, SD-0.33) periods with a p value of >0.05 as per ANOVA two factor without replication test. Therefore we do not reject the null hypothesis that there is no difference in serum potassium levels distribution between the study periods.

Chloride



Serum Chloride Groups	Pre-operative	Intra-operative	Post-operative	Pre-operative (%)	Intra-operative (%)	Post-operative (%)
≤ 100 meq/l	10	0	4	25.00	0.00	10.00
101-105 meq/l	12	6	14	30.00	37.50	35.00
106-110 meq/l	14	9	15	35.00	56.25	37.50
111-115 meq/l	4	1	6	10.00	6.25	15.00
> 115 meq/l	0	0	1	0.00	0.00	2.50
Total	40	16	40	100.00	100.00	100.00

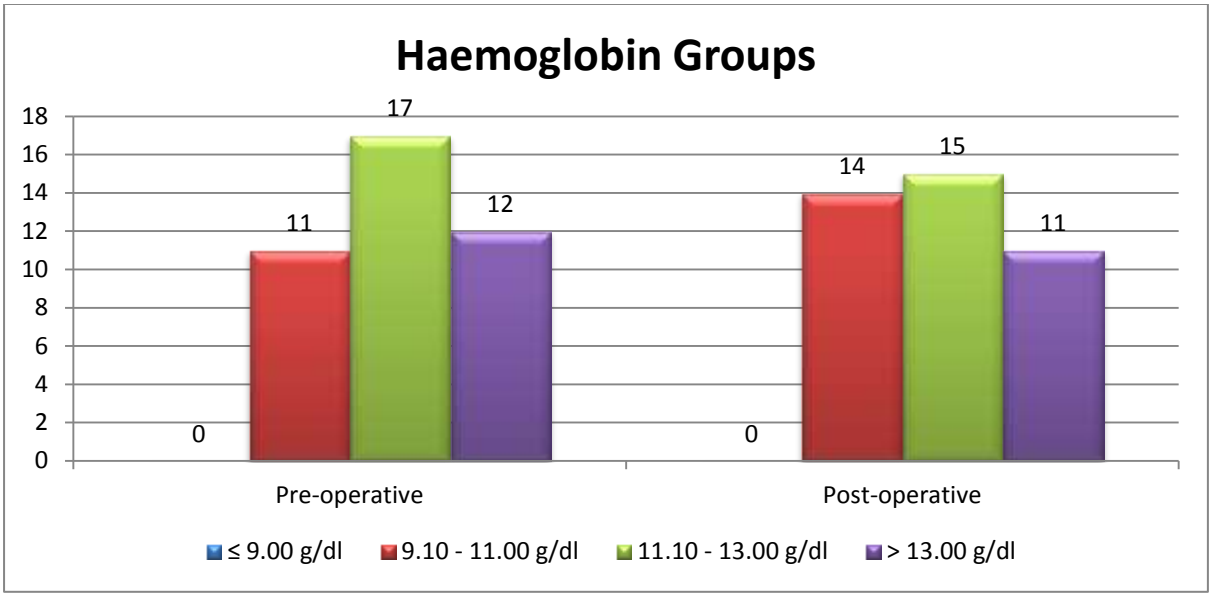
Serum Chloride Distribution	Pre-operative	Intra-operative	Post-operative
Mean	104.45	106.08	106.56
SD	5.07	4.46	1.74
P value Paired t Test	Pre-operative Vs Intra-operative		0.0382
	Intra-operative Vs Post-operative		0.5030
	Pre-operative Vs Post-operative		0.0053
P value ANOVA Two Factor Without Replication Test	0.0002		

Among the study patients, there was a statistically significant difference in relation to Serum chloride distribution between the pre-operative (mean-104.45, SD-5.07), intra-operative (mean-106.08, SD-4.46) and post-operative (mean-106.56, SD-1.74) periods with a p value of <0.05 as per ANOVA two factor without replication test. Therefore we reject the null hypothesis that there is no difference in serum chloride levels distribution between the study periods.

Conclusion

In this study we can safely conclude that there is a sustained increase of serum chloride levels among study subjects from pre-operative to post-operative stage. This indicates that when normal saline is used as irrigation solution in percutaneous nephrolithotomy, there is a tendency for development of hyperchloremia post-operatively.

Hemoglobin

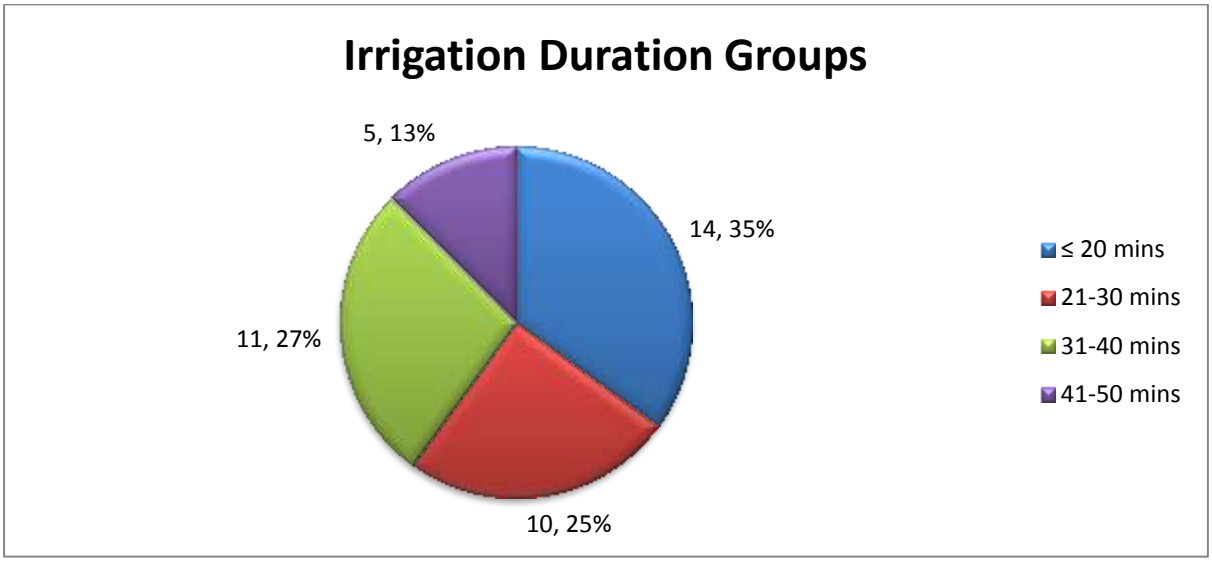


Haemoglobin Groups	Pre-operative	Post-operative	Pre-operative (%)	Post-operative (%)
≤ 9.00 g/dl	0	0	0.00	0.00
9.10 - 11.00 g/dl	11	14	27.50	35.00
11.10 - 13.00 g/dl	17	15	42.50	37.50
> 13.00 g/dl	12	11	30.00	27.50
Total	40	40	100.00	100.00

Hemoglobin Distribution	Pre-operative	Post-operative
Mean	12.18	11.92
SD	1.35	1.32
P value Paired t Test	0.0722	

Among the study patients, there was no statistically significant difference in relation to haemoglobin distribution between the pre-operative (mean-12.18, SD-1.40) and post-operative (mean-11.92, SD-1.38) periods with a p value of >0.05 as per paired t test. Therefore we do not reject the null hypothesis that there is no difference in hemoglobin levels distribution between the study periods.

Irrigation Duration

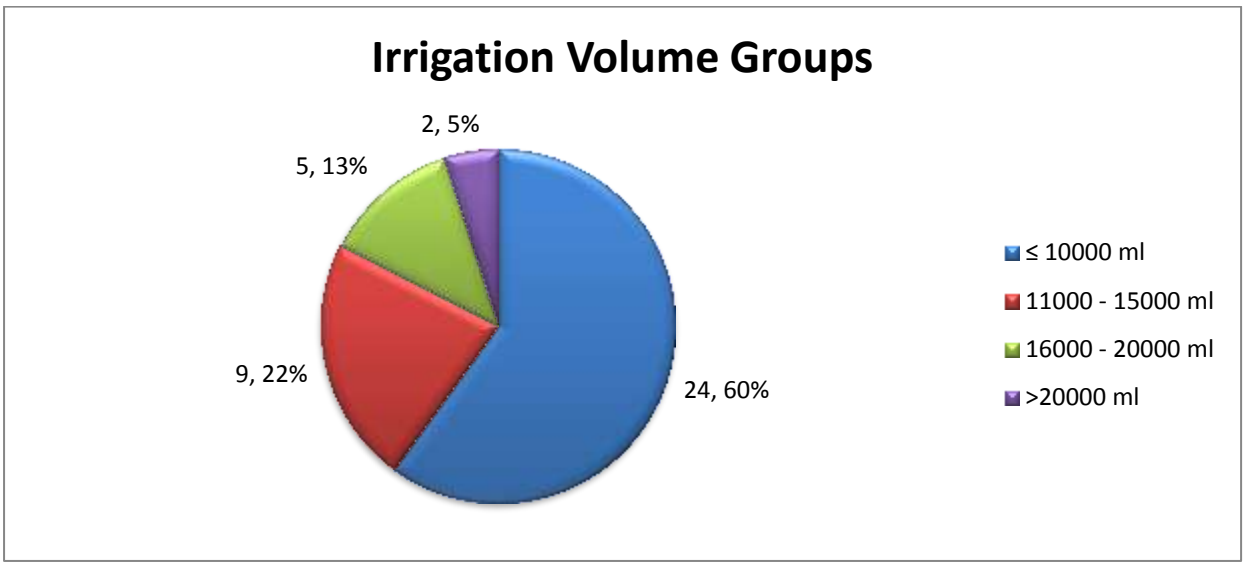


Irrigation Duration Groups	Number of Observations	%
≤ 20 mins	14	35.00
21-30 mins	10	25.00
31-40 mins	11	27.50
41-50 mins	5	12.50
Total	40	100.00

Irrigation Duration Distribution	Values (mins)
Mean	29.50
SD	10.05

On analyzing irrigation duration distribution, most of the study subjects (n=14, 35.00%) were clustered in the ≤ 20 mins group followed by 31-40 mins group (n=11, 27.50%) The mean irrigation duration was 29.50 minutes.

Irrigation Volume

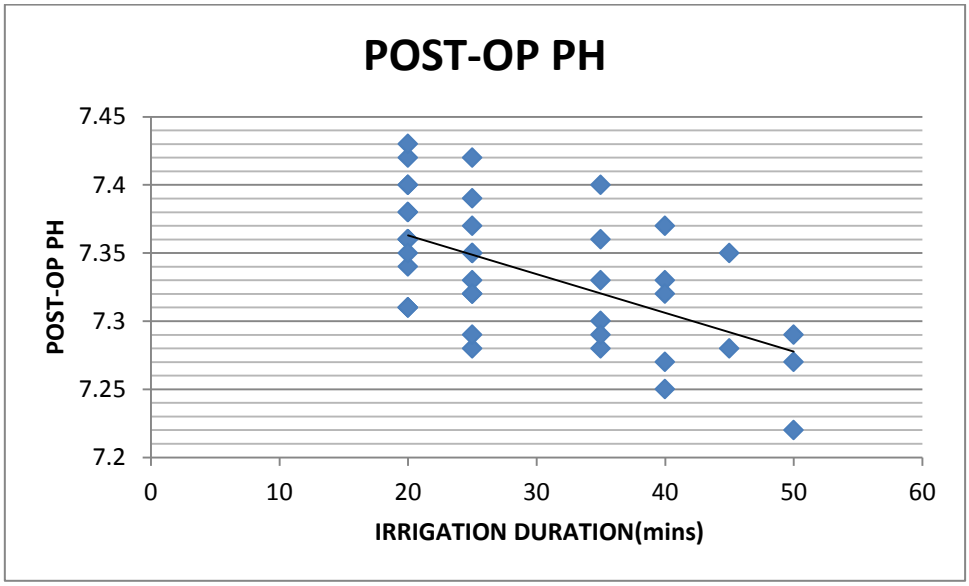


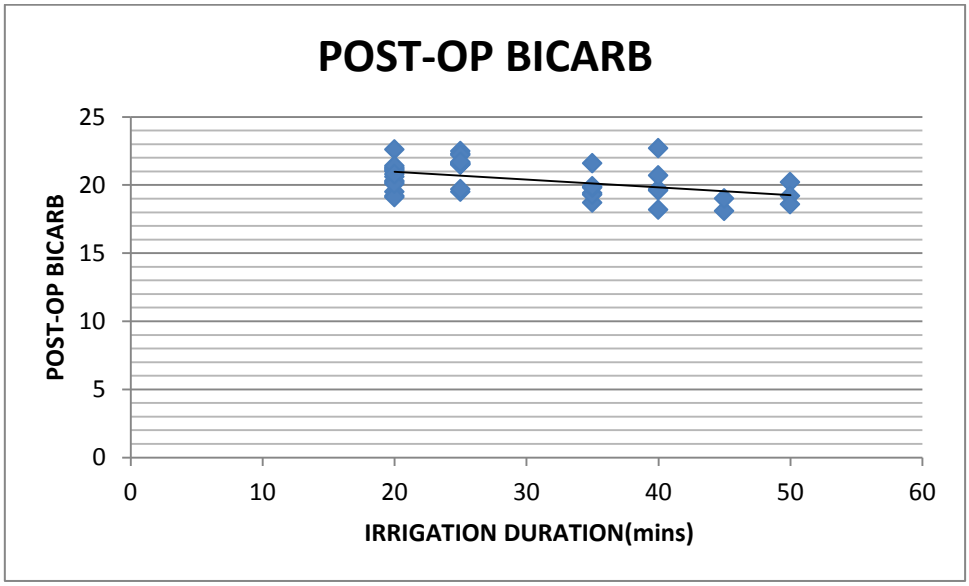
Irrigation Volume Groups	Number of Observations	%
≤ 10000 ml	24	60.00
11000 - 15000 ml	9	22.50
16000 - 20000 ml	5	12.50
>20000 ml	2	5.00
Total	40	100.00

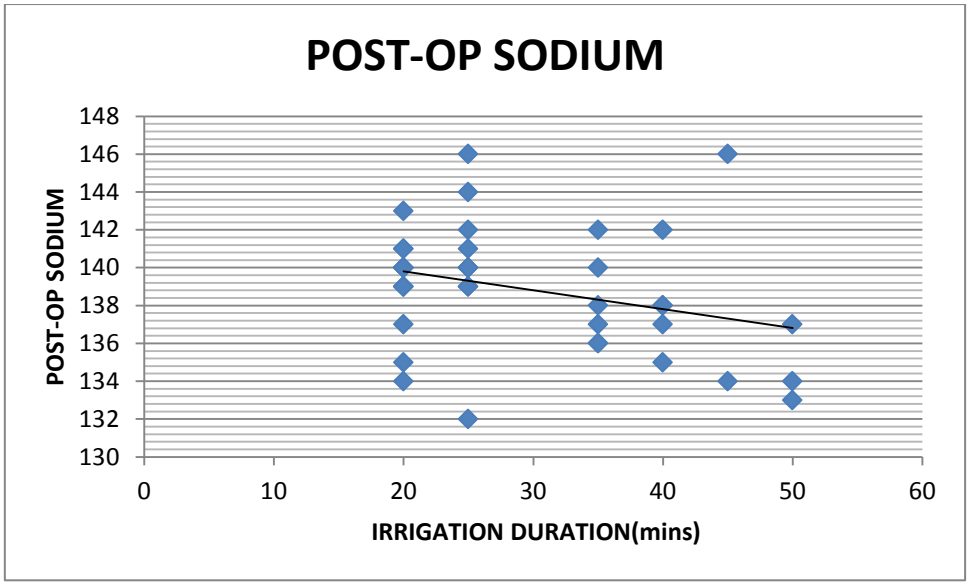
Irrigation Volume Distribution	Values (ml)
Mean	11037.50
SD	4489.86

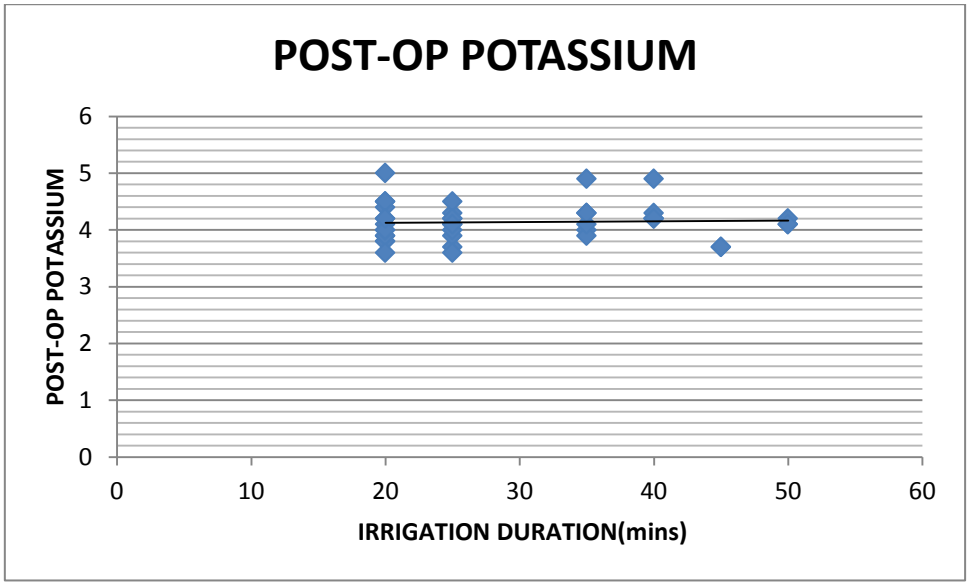
On analyzing irrigation volume distribution, most of the study subjects (n=24, 60.00%) were clustered in the ≤ 10000 ml group followed by 11000-15000 ml group (n=9, 22.50%) The mean irrigation volume was 11038 ml.

Correlation – Irrigation Duration Vs Post Operative Parameters






POST-OP SODIUM
148
146
144
142
140
138
136
134
132
130
POST-OP SODIUM
0
10
20
30
40
50
60
IRRIGATION DURATION(mins)


POST-OP POTASSIUM
6
5
4
3
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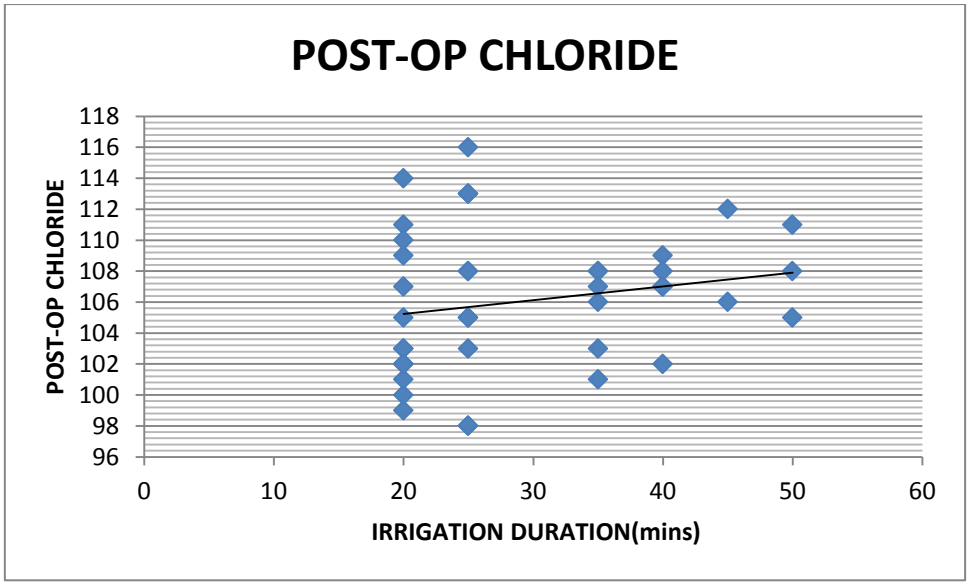
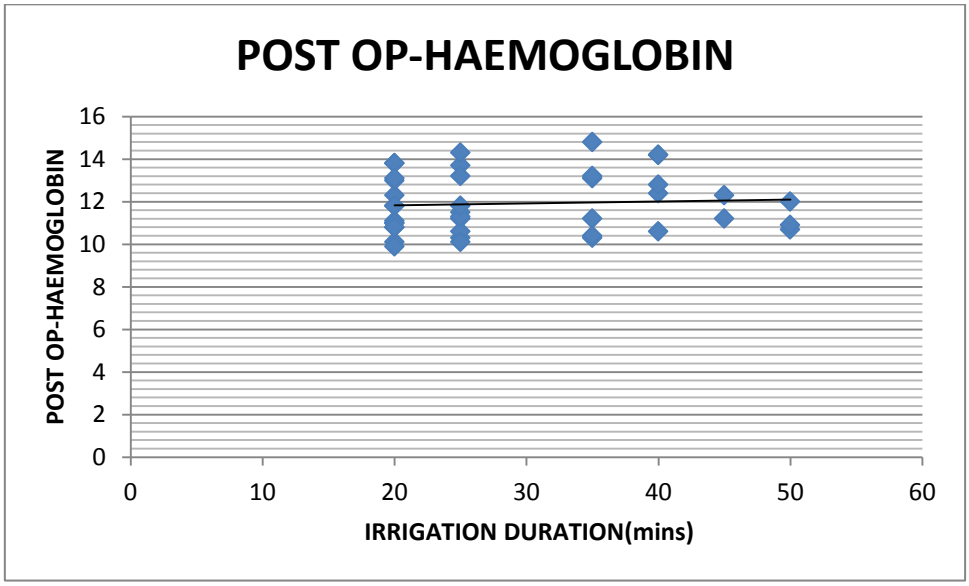
1
0
POST-OP POTASSIUM
0
10
20
30
40
50
60
IRRIGATION DURATION(mins)





Correlation - Irrigation Duration VsPost Operative Parameters	Irrigation Duration (mins)	pH	Bicarbonate (mmol/l)	Sodium (meq/l)	Potassium (meq/l)	Chloride (meq/l)	Haemoglobin (g/dl)
Mean	29.50	7.34	20.43	138.85	4.14	106.08	11.92
SD	10.05	0.05	1.26	3.26	0.33	4.46	1.38
Pearson's R Correlation		-0.57	-0.46	-0.31	0.04	0.20	0.07
R^2		0.3301	0.2094	0.0094	0.0017	0.0404	0.0046
P value		0.0001	0.0039	0.0645	0.7732	0.2318	0.7332

Results

In study subjects when normal saline is used as irrigation solutionin percutaneous nephrolithotomy,whenirrigation duration was cross matched against post-operative parameters, the mean irrigation duration was 29.50 mins, the mean pH was 7.34, the mean bicarbonate level was 20.43 mmol/l, the mean sodium level was 138.35 meq/ml, the mean potassium level was 4.14 meq/ml, the mean chloride level was 106.08 meq/ml and mean haemoglobin level was 13.92 gm/dl.

The relationship in values between irrigation duration and pH is statistically significant as the p value is 0.0001 with a negative correlation as per pearson's coefficient of -0.57

The relationship in values between irrigation duration and bicarbonate level is statistically significant as the p value is 0.0039 with a negative correlation as per pearson's coefficient of -0.46

The relationship in values between irrigation duration and sodiumlelevel is not statistically significant as the p value is >0.05 with a negative correlation as per pearson's coefficient of -0.31

The relationship in values between irrigation durationandpotassium level is not statistically significant as the p value is >0.05 with a positive correlation as per pearson's coefficient of 0.04

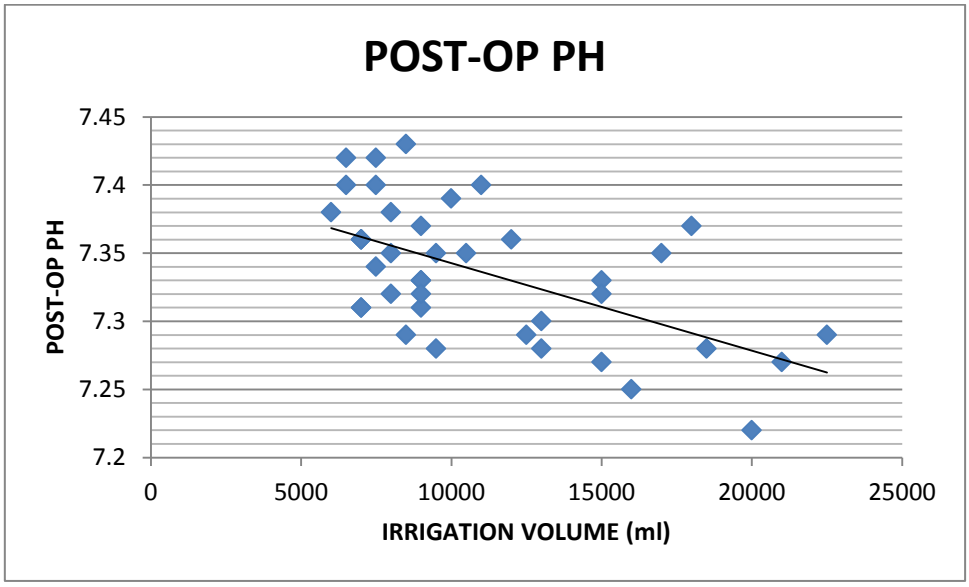
The relationship in values between irrigation duration and chloride level is not statistically significant as the p value is >0.05 with a positive correlation as per pearson's coefficient of 0.20

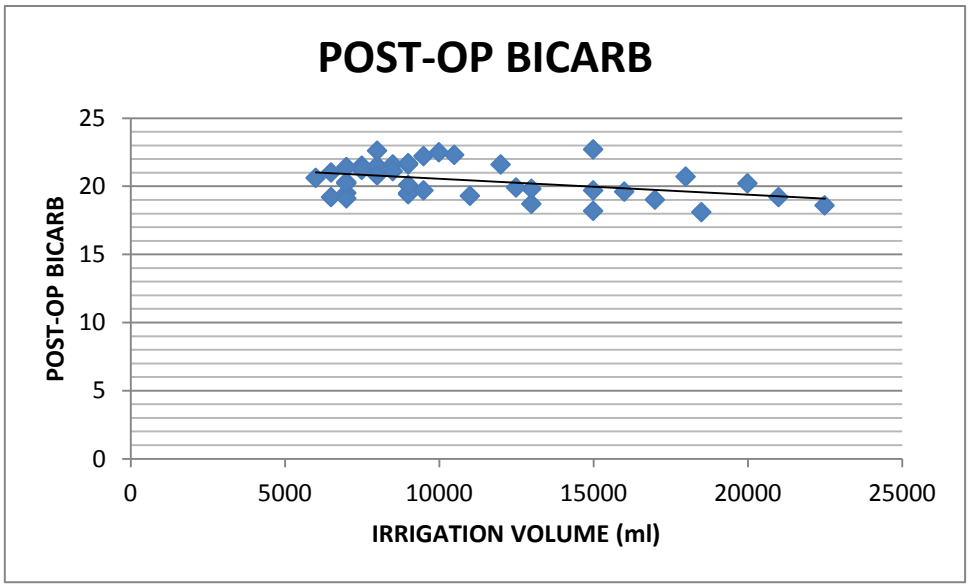
The relationship in values between irrigation duration and haemoglobin level is not statistically significant as the p value is >0.05 with a positive correlation as per pearson's coefficient of 0.07

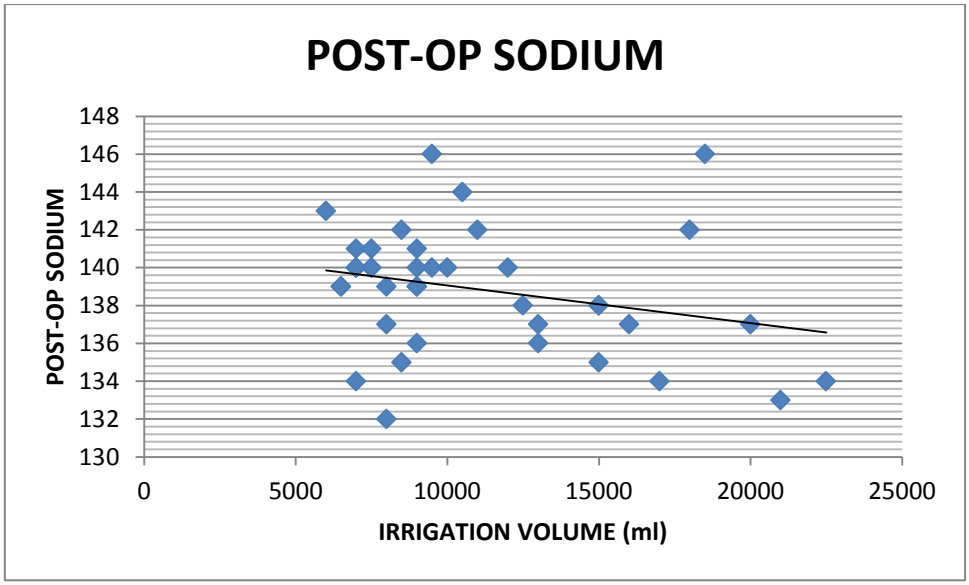
Conclusion

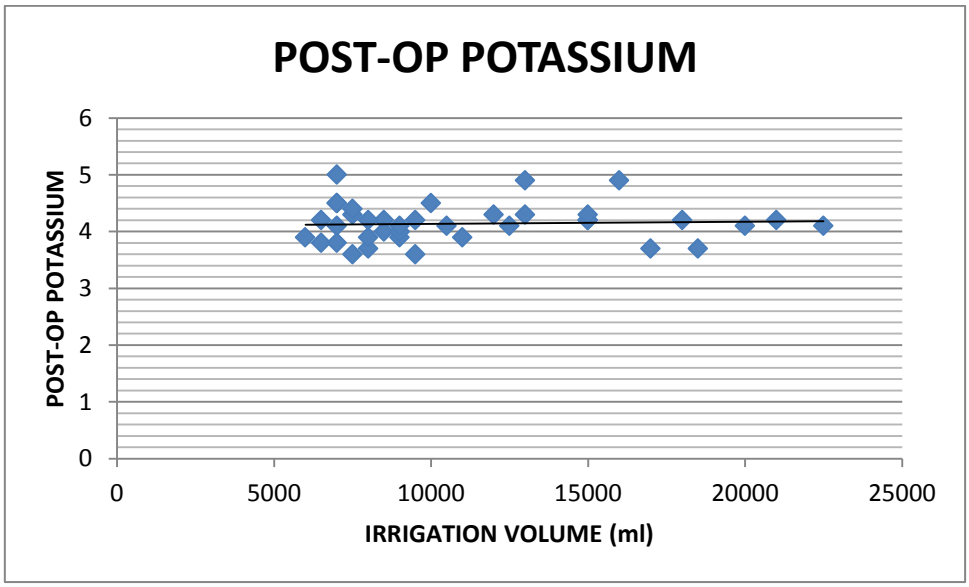
In this study we can safely conclude that the results are statistically significant i ndicating that there is enough evidence to suggest that mean pH and bicarbonate levels decreased consistently and linearly with increase in irrigation duration at 5% significance level.

Correlation – IrrigationVolume Vs Post Operative Parameters






POST-OP SODIUM
148
146
144
142
140
138
136
134
132
130
POST-OP SODIUM
0
5000
10000
15000
20000
25000
IRRIGATION VOLUME (ml)


POST-OP POTASSIUM
6
5
4
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0
POST-OP POTASSIUM
0
5000
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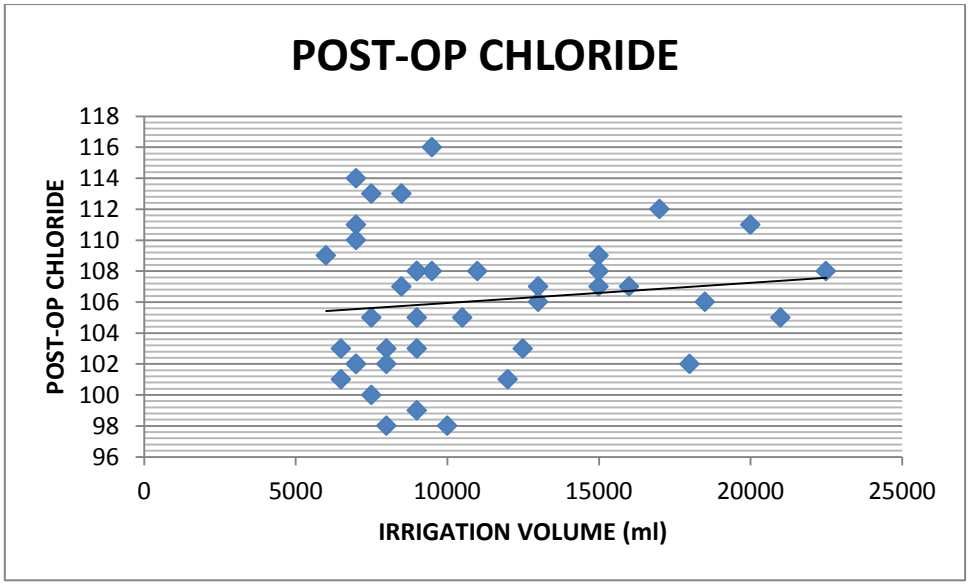
15000
20000
25000
IRRIGATION VOLUME (ml)


POST-OP CHLORIDE
POST-OP CHLORIDE
118
116
114
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108
106
104
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100
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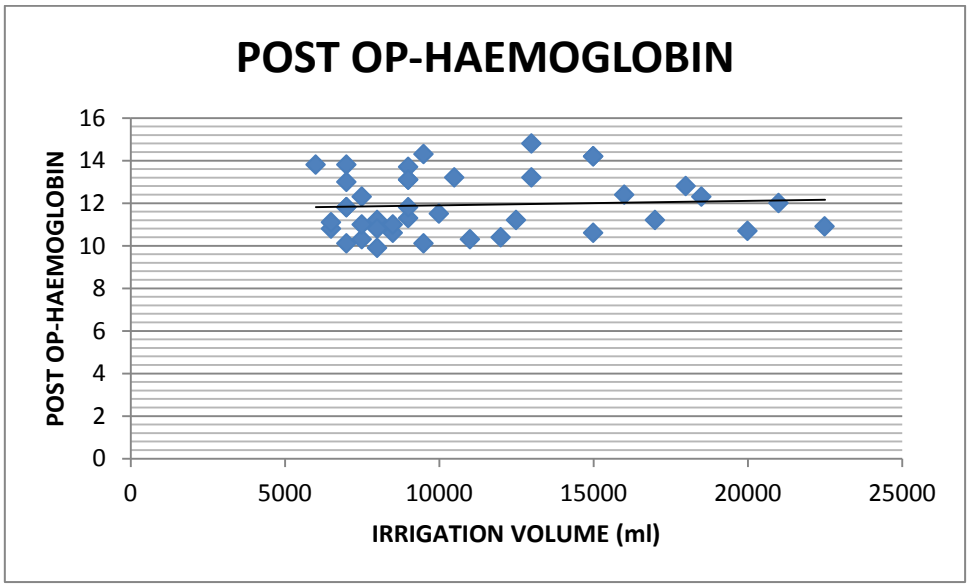
20000
25000
IRRIGATION VOLUME (ml)


POST OP-HAEMOGLOBIN
POST OP-HAEMOGLOBIN
16
14
12
10
8
6
4
2
0
0
5000
10000
15000
20000
25000
IRRIGATION VOLUME (ml)

Correlation - Irrigation Volume Vs Post Operative Parameters	Irrigation Volume (ml)	Ph	Bicarbonate (mmol/l)	Sodium (meq/l)	Potassium (meq/l)	Chloride (meq/l)	Haemoglobin (g/dl)
Mean	11037.50	7.34	20.43	138.85	4.14	106.08	11.92
SD	4489.86	0.05	1.26	3.26	0.33	4.46	1.38
Pearson's R Correlation		-0.58	-0.41	-0.27	0.05	0.13	0.07
R^2		0.3338	0.1721	0.0748	0.0028	0.0017	0.0047
P value		0.0001	0.0064	0.0758	0.7713	0.4083	0.6312

Results

In study subjects when normal saline is used as irrigation solution in percutaneous nephrolithotomy, when irrigation volume was cross matched against post-operative parameters, the mean irrigation volume was 11037 ml, the mean pH was 7.34, the mean bicarbonate level was 20.43 mmol/l, the mean sodium level was 138.35 meq/ml, the mean potassium level was 4.14 meq/ml, the mean chloride level was 106.08 meq/ml and mean haemoglobin level was 13.92 gm/dl.

The relationship in values between irrigation volume and pH is statistically significant as the p value is 0.0001 with a negative correlation as per pearson's coefficient of -0.58

The relationship in values between irrigation volume and bicarbonate level is statistically significant as the p value is 0.0039 with a negative correlation as per pearson's coefficient of -0.41

The relationship in values between irrigation volume and sodium level is not statistically significant as the p value is >0.05 with a negative correlation as per pearson's coefficient of -0.27

The relationship in values between irrigation volume and potassium level is not statistically significant as the p value is >0.05 with a positive correlation as per pearson's coefficient of 0.05

The relationship in values between irrigation volume and chloride level is not statistically significant as the p value is >0.05 with a positive correlation as per pearson's coefficient of 0.13

The relationship in values between irrigation volume and haemoglobin level is not statistically significant as the p value is >0.05 with a positive correlation as per pearson's coefficient of 0.07

Conclusion

In this study we can safely conclude that the results are statistically significant indicating that there is enough evidence to suggest that mean pH and bicarbonate levels decreased consistently and linearly with increase in irrigation volume at 5% significance level.

DISCUSSION

PCNL is a widely accepted method for removal of renal stones with many advantages. However, various studies have assessed haemodynamic, electrolyte and metabolic changes during this procedure. Mechanical handling of kidney and continuous irrigation may be expected to give rise to certain disturbances in homeostasis and haemodynamic balance, thus making it important to study the changes in various parameters.

Our Study Outcome Measures :

Serum Sodium, Potassium, Chloride, pH & Bicarbonate values were recorded in Preoperative(baseline), Intraoperative (30mins after irrigation) and in Postoperative periods and to correlate the above electrolyte and metabolic changes with duration of irrigation and volume of irrigation fluid infused. Study also compared the preoperative and postoperative Haemoglobin levels.

In our study mean pH distribution levels were significantly less intra-operatively compared to pre-operative levels by a mean difference of 0.03 indicates that 79% of the subjects intra-operatively will have a decreased pH value compared to pre-operative value with significant statisticial p-value. The mean pH distribution levels were significantly less post-operatively compared to intra-operative levels by a mean difference of 0.02(effect size=0.8).This means that 79% of the subjects post-operatively will have a decreased pH value

compared to intra-operative stage with a significant p-value of 0.0330. The mean pH distribution levels were significantly less post-operatively compared to pre-operative levels by a mean difference of 0.05(effect size=0.9).This means that 82% of the subjects post-operatively will have a decreased pH value compared to preoperative stage with statistical significance indicating the chances of acidosis.

This result is similar to the study conducted by Medha Mohta[22] et al in which there was a tendency towards metabolic acidosis with increase in duration of irrigation and volume of absorbed irrigant fluid.

In Our study, mean bicarbonate distribution levels were significantly less intra-operatively compared to pre-operative levels by a mean difference of 0.53.This means that 69% of the subjects intra-operatively will have a decreased bicarbonate value compared to pre-operative value with statistical significance. Also bicarbonate levels were significantly less post-operatively compared to intra-operative levels by a mean difference of 0.79 indicating that 88% of the subjects post -operatively will have a decreased bicarbonate value compared to intra-operative value. This difference is significant with a p-value of 0.0001. The mean bicarbonate levels were significantly less post-operatively compared to pre-operative levels by a mean difference of 1.32 indicates that 84% of the subjects post-operatively will have a decreased bicarbonate value compared to

preoperative stage with statistically significant p-value of <0.0001 as per paired t-test.

In a study conducted by Akash gupta[3] et al, there was decrease in bicarbonate levels with increase in duration of irrigation with tendency towards metabolic acidosis.

Above result is similar to study published in Atici[1] et al where there was metabolic acidosis due to decrease in bicarbonate levels.

In our study, mean serum sodium distribution levels were not significantly less pre-operatively compared to intra-operative levels with a p-value of 0.3937 as per paired t-test. The mean serum sodium distribution levels were significantly less post-operatively compared to intra-operative levels by a mean difference of 2.15 indicates that 96% of the subjects post-operatively will have a decreased serum sodium value compared to intra-operative stage and this difference is significant . The mean serum sodium distribution levels were significantly less post-operatively compared to pre-operative levels by a mean difference of 1.75 indicates that 69% of the subjects post-operatively will have a decreased sodium value compared to pre-operative stage and difference is significant with a p-value of 0.0104 .

Medha Mohta[22] et al reported that Serum sodium and potassium values did not change significantly during or after irrigation.

Atici[1] et al. reported hyponatremia and hypokalemia and explained these changes by renal tubular dysfunction due to mechanical irritation of kidneys.

In our study, there was no statistically significant difference in relation to serum potassium levels between the pre-operative, intra-operative and post-operative periods with a p value of >0.05.

In the study by Gehring[12] et al, the main aim was to compare groups with intravascular versus extravascular absorption. However electrolyte values before irrigation and at discharge from the recovery room in individual groups were not found to be different.

In our study group, mean serum chloride distribution levels were significantly more intra-operatively compared to pre-operative levels by a mean difference of 1.63 indicates that 66% of the subjects intra -operatively will have a increased serum chloride value compared to pre-operative stage with significant p-value of 0.0382.The mean serum chloride distribution levels were not significantly less intra-operatively compared to post-operative levels with a p-value of 0.5030. The mean serum chloride distribution levels were significantly more post-operatively compared to pre-operative levels by a mean difference of 2.11 which indicates that 88% of the subjects post-operatively will have a increased serum chloride value compared to pre-operative value with significant p-value of 0.0053.

Koroglu [16] et al. monitored all the variables at 10-min intervals, but compared values before, during and after irrigation. There was no significant difference in fluid –electrolyte balance and hemodynamics related to both irrigation volume and irrigation duration when 0.9% normal saline was used in Percutaneous nephrolithotomy.

In our study, there was no statistically significant difference in relation to hemoglobin distribution between the pre-operative and post-operative periods with a p value of >0.05 as per paired t test.

In our study when normal saline is used as irrigation solution in percutaneous nephrolithotomy, when irrigation duration was cross matched against post-operative parameters, the mean irrigation duration was 29.50 mins, the mean pH was 7.34, the mean bicarbonate level was 20.43 mmol/l, the mean sodium level was 138.35 meq/ml, the mean potassium level was 4.14 meq/ml, the mean chloride level was 106.08 meq/ml and mean haemoglobin level was 13.92 gm/dl.

The relationship in values between irrigation duration and pH is statistically significant as the p value is 0.0001 with a negative correlation as per pearson's coefficient of -0.57 .The relationship in values between irrigation duration and bicarbonate level is statistically significant as the p value is 0.0039 with a negative correlation as per pearson's coefficient of -0.46 .The linear increase in irrigation duration measurement in relation to increased pH levels is

true 57% of times. But out of the 57% only 33% of the variation in mean pH levels can be predicted from the relationship between irrigation duration and pH levels. When the irrigation duration increases there is a corresponding decrease in pH levels.

The linear increase in irrigation duration measurement in relation to increased bicarbonate levels is true 46% of times. But out of this 46% only 21% of the variation in mean bicarbonate levels can be predicted from the relationship between irrigation duration and bicarbonate levels. When the irrigation duration increases there is a corresponding decrease in bicarbonate levels.

. In a study conducted by Vahit Guzelburc[29] et al, increase in irrigation duration and volume of irrigation fluid used leads to significant increase in irrigation fluid absorption in PCNL group.

The increase in levels of irrigation volume correlates negatively and moderately with the increase in pH levels. The linear increase in irrigation volume measurement in relation to increased pH levels is true 58% of times. But out of the 58% only 33% of the variation in mean pH levels can be predicted from the relationship between irrigation volume and pH levels. When the irrigation volume increases there is a corresponding decrease in pH levels.

The increase in levels of irrigation volume correlates negatively and moderately with the increase in bicarbonate levels. The linear increase in irrigation volume measurement in relation to increased bicarbonate levels is true 41% of times. But out of this 41% only 17% of the variation in mean bicarbonate levels can be predicted from the relationship between irrigation volume and bicarbonate levels. When the irrigation volume increases there is a corresponding decrease in bicarbonate levels.

Kukreja Ra[17] et al reported that reducing the nephroscopy time and the amount of irrigation fluid used and staging the procedure for large renal stones reduces fluid absorption and avoids volume overload.

In our study we included a total of 40 subjects, among whom 16 subjects had duration of irrigation exceeded more than 30 minutes with the increasing irrigation volume infused .Maximum duration of irrigation was 50 minutes and the maximum volume of irrigation fluid infused was 22500ml.The mean duration of irrigation was 29.50 minutes and the mean volume of irrigation was 11038 ml. We found that electrolyte and metabolic changes were frequently recorded in the subjects with increasing irrigation duration and irrigation volume. Therefore it is advisable to monitor arterial blood gases in patients during and after PCNL in case of increased irrigation duration and irrigation volume, previously compromised renal functions and metabolic status.

SUMMARY

Percutaneous nephrolithotomy (PCNL) is a surgical procedure done for the treatment of renal stones which involves continuous use of irrigation solution. Normal saline is the commonly used irrigation solution. Systemic absorption of this irrigation solution leads to electrolyte and acid – base disturbances, circulatory disturbances and neurological problems. In our study we evaluated the electrolyte and acid- base disturbances occurring in PCNL and its relation to irrigation time and irrigation volume.

METHODS: After IEC approval a prospective study was conducted in 40 patients belonging to ASA-PS I and II undergoing PCNL. After obtaining informed consent from the patients, baseline electrolytes, pH, bicarbonate, haemoglobin and vital data were recorded. Patient underwent PCNL procedure under general anaesthesia. Patient turned into prone position and procedure started with the use of irrigation solution. Intra-operatively electrolytes, pH and bicarbonate recorded if the duration of irrigation exceeded 30 minutes. Irrigation duration and volume recorded. After completion of procedure, patient extubated and postop electrolytes, pH and bicarbonate, haemoglobin were recorded in the recovery room.

INTERPRETATIONS:

- In our study serum pH level was decreasing significantly from the preop

level to the intraop levels by a mean difference of 0.03 and to postop levels by a mean difference of 0.05.

- Serum bicarbonate was decreasing significantly from the preop level to the intraop levels by a mean difference of 0.53 and to postop levels by a mean difference of 1.32.
- The mean serum sodium levels was significantly less post-operatively compared to intra-operative levels by a mean difference of 2.15 and also serum sodium were significantly less post-operatively compared to pre-operative levels by a mean difference of 1.75.
- The mean serum chloride distribution levels were significantly more intra-operatively compared to pre-operative levels and also serum chloride were significantly more post-operatively compared to pre-operative levels .
- There was no statistically significant difference in relation to potassium and Haemoglobin distribution between the pre-op and post-operative periods.
- The relationship in values between irrigation duration and pH is statistically significant with the p value of 0.0001 with a negative correlation. Also the relationship between irrigation duration and bicarbonate level is statistically significant with the p value of 0.0039 with a negative correlation.
- The increase in levels of irrigation volume correlates negatively with the increase in pH levels. Also the increase in levels of irrigation volume correlates negatively with the increase in bicarbonate levels.

CONCLUSION

In this study, I conclude that when normal saline was used as an irrigation solution in percutaneous nephrolithotomy,mean pH and serum bicarbonate levels decreased consistently and linearly leading to metabolic acidosis with the increase in irrigation duration and irrigation volume. Also there was a tendency for hyponatremia and hyperchloremia postoperatively.

Also I conclude that there was no significant change in serum potassium and haemoglobin levels.

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2. SMITH'S TEXT BOOK OF ENDOUROLOGY THIRD EDITION

3. MILLER'S TEXT BOOK OF ANAESTHESIA EIGHTH EDITION

ANNEXURES

PROFORMA

Title: "EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION-A PROSPECTIVE STUDY"

Date: Roll No:

Name:

Age: Sex: IP No:

Diagnosis:

Surgical Procedure

Ht: CVS:

Wt: RS:

Pre OP Assessment

History

Any Co-morbid Illness

H/o. Previous Surgeries

AIRWAY

MMS :

TMD/IID/NM :

Dentition :

INVESTIGATIONS

Pre-op Hb :

Urea :

Creatinine :

Informed Consent in Tamil:

Baseline Electrolyte and Metabolic Values Recorded

Shifted to OT / Baseline NIBP,HR ,SPO_2 were recorded

Premedication/Preoxygenation / Induction / Intubation

Prone position/procedure started

Maintenance of anaesthesia done /Intraop vital parameters monitored

Electrolyte and Metabolic Changes recorded 30 Mins after irrigation

End of Surgery (Duration of irrigation in ___ mins) &
(Volume of irrigation solution infused ___ml) were noted

Reversed and extubated

Electrolyte and metabolic changes were recorded in post operative period

Compilation of Data

Electrolyte and Acid Base Status

	Baseline	**Intra operative (30 min after irrigation)**	**Post Operative**
Sr.Na^+(meq/L)			
Sr.K^+(meq/L)			
Sr.Cl^-(meq/L)			
pH			
HCO_3^-			

Primary Outcome measures

- Serum Sodium, Potassium, Chloride, pH & Bicarbonate values were recorded in Preoperative (baseline), Intraoperative (30 mins after irrigation) and in Postoperative periods.
- To correlate the above electrolyte and metabolic changes with duration of irrigation and volume of irrigation fluid infused.

Secondary outcome measures

- To compare preoperative and postoperative Haemoglobin levels.

INFORMATION TO PARTICIPANTS

Investigator : **Dr.G.ARUN SEKAR**

Name of the Participant :

Title: **"**EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION-A PROSPECTIVE STUDY**"**

You are invited to take part in this research study. We have got approval from the IEC. You are asked to participate because you satisfy the eligibility criteria.

We want to evaluate Electrolyte and Metabolic Changes in Percutaneous Nephrolithotomy using Normal saline as Irrigation Solution.

What is the purpose of the Research

1) Serum Sodium, Potassium, Chloride, pH & Bicarbonate values were recorded in Preoperative (baseline), Intraoperative (30 mins after irrigation) and in Postoperative periods.

2) To correlate the above electrolyte and metabolic changes with duration of irrigation and volume of irrigation fluid infused.

3) To compare preoperative and postoperative Haemoglobin levels.

The Study Design

A prospective study- involving 40 patients.

Discomforts

- Taking a blood sample with a needle may be painful, so a local pain reliever is administered to prevent discomfort before the blood is drawn.
- Other discomforts like Post Operative Sore Throat, Nausea, Vomiting, Can occur.

This intervention has been shown to be well tolerated as shown by previous studies. And if you do not want to participate you will have alternative, of setting the standard treatment and your safety is our prime concern.

Signature/ Thumb Impression of Patient

Date :
Place :

Patient Name

Signature of the Investigator _____

Name of the Investigator _____

PATIENT CONSENT FORM

Study Title

"EVALUATION OF ELECTROLYTE AND METABOLIC CHANGES IN PERCUTANEOUS NEPHROLITHOTOMY USING NORMAL SALINE AS IRRIGATION SOLUTION -A PROSPECTIVE STUDY"

Study Centre

Institute of Anaesthesiology and Critical Care,
Rajiv Gandhi Govt. General Hospital,
Madras Medical College, Chennai – 600003.

Participant Name:

IP No: Age: Sex:

In confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask the question and all my questions and doubts have been answered to my satisfaction.

I have been explained about the pitfall in the procedure. I have been explained about the safety, advantage and disadvantage of the technique.

I understand that my participation in the study voluntary and that I am free to withdraw at anytime without giving any reason.

I understand that investigator, regulatory authorities and the ethics committee will not need my permission to look at the health records both in respect to current study and any further research that may be conducted in relation to it, even if I withdraw from the study.

I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from the study. I hereby give permission to undergo complete clinical examination and diagnostic tests

including haematological, biochemical, radiological tests.

I hereby agree to participate in this study.

Signature/ Thumb Impression of Patient

Date :
Place :

Patient Name

Signature of the Investigator _____

Name of the Investigator _____

நோயாளியின் ஆராய்ச்சி தகவல் படிவம்

ஆராய்ச்சியின் தலைப்பு

''நார்மல் சலைன்'' எனப்படும் உப்பு கரைசலை ஊசித்துளை சிறுநீரக அறுவை சிகிச்சையின் நீர்பாய்ச்சலுக்கு உபயோகிக்கும்போது ஏற்படும் தாது உப்புகள் மற்றும் அமிலம் கார சமநிலை மாற்றத்தினை மதிப்பிடும் வருங்கால ஆய்வு.

ஆராய்ச்சியாளரின் பெயர் : மரு.கு.அருண் சேகர்

பங்கேற்பாளர் பெயர் :

ஆராய்ச்சியின் நோக்கம்

1) சீரம் சோடியம், பொட்டாசியம், குளோரைடு, பி.எச். மற்றும் பைகார்பனேட்டின் அளவுகள் அறுவை சிகிச்சைக்கு முன், அறுவை சிகிச்சையின் பொழுது (முப்பது நிமிடங்கள் நீர் பாய்ச்சலுக்கு பிறகு), அறுவை சிகிச்சைக்கு பின் பதிவு செய்யப்பட்டன.
2) மேலே ஏற்பட்டுள்ள தாது உப்புகள் மற்றும் அமிலம் கார சமநிலை மாற்றத்தினை பாசன காலம் மற்றும் பாசன திரவ தொகுதியுடன் ஒப்பிட்டு தொடர்பிருப்பதாக பார்த்தல்.
3) அறுவை சிகிச்சைக்கு முன், பின் உள்ள ஹீமோகுளோபின் அளவை ஒப்பிட்டு பார்த்தல்.

பக்க விளைவுகள்

இரத்த மாதிரிகள் எடுக்கும்பொழுது அசௌகரியம் ஏற்படலாம். மரத்துப்போகும் ஊசியின் மூலம் இது தவிர்க்கப்படும்.

இந்த முறையான ஆய்வு ஏற்கனவே பல இடங்களில் நடத்தப்பட்டுள்ளது. மேலும் இதன் பாதுகாப்பு உறுதி செய்யப்பட்டுள்ளது. உங்கள் பாதுகாப்பே எங்களின் முக்கிய நோக்கம்.

இந்த ஆய்வு சம்பந்தமான எல்லா புள்ளி விவரங்கள் மற்றும் நோயாளிகளின் விவரங்கள் ரகசியமாக வைக்கப்படும். இந்த ஆய்வு சம்பந்தப்பட்ட எல்லா பரிசோதனைகள், மருந்துகள் மற்றும் மருத்துவ சேவைகள் அனைத்து நோயாளிகளுக்கும் இலவசமாக வழங்கப்படும்.

ஆய்வாளரின் பெயர் **பங்கு பெறுபவரின் பெயர்**

ஆய்வாளரின் கையொப்பம் **பங்கு பெறுபவரின் கையொப்பம்**

S. No	NAME	AGE/ SEX	IP NO	ASA-PS	BL-pH	BL-BICARB	BL-SODIUM	BL-POTASSIUM	BL-CHLORIDE	BL-HAEMO GLOBIN	INTRA-OP-PH	INTRA- OP BICARB	INTRA-OP SODIUM	INTRA-OP POTASSIUM	INTRA-OP CHLORIDE	POST-OP PH	POST-OP BICARB	POST-OP SODIUM	POST-OP POTASSIUM	POST-OP CHLORIDE	POST OP-HAEMO GLOBIN	IRRIGATION DURATION (mins)	IRRIGATION VOLUME (ml)
1	PALANI	53/M	31555	1	7.34	21.4	138	3.9	106	13.4	7.34	21.1	140	3.6	108	7.33	19.4	136	4	108	13.1	35	9000
2	ARUMUGAM	56/M	29293	2	7.36	21.4	137	4.1	105	11						7.36	19.5	141	4.5	102	10.1	20	7000
3	KANAGA	50/F	30156	1	7.45	22.2	136	4.1	110	10.7						7.42	21.5	140	4.3	113	10.3	25	7500
4	DURAI RAJ	6O/M	27775	2	7.35	21.5	136	3.9	102	10.6						7.32	21.5	132	3.7	98	11.2	25	8000
5	VEERAMANI	42/M	36827	1	7.38	21.2	138	4.2	104	14.3						7.38	20.6	143	3.9	109	13.8	20	6000
6	PENCILLIAH	42/M	29725	1	7.37	20.5	143	5	110	14.4						7.31	20.3	140	5	114	13.8	20	7000
7	PALANISAMY	53/M	31093	1	7.36	21.2	145	4.7	104	14.7	7.32	20.1	143	4.6	105	7.27	18.2	138	4.2	109	14.2	40	15000
8	SABEENA	48/F	27178	1	7.4	19.9	137	4.1	106	11.3						7.4	19.2	139	3.8	103	10.8	20	6500
9	RAVICHANDRAN	28/M	37280	1	7.35	21.5	143	4	105	13.8	7.32	20.5	141	4	106	7.3	18.7	136	4.3	106	13.2	35	13000
10	SUNDARAMMAL	58/F	35830	2	7.41	24.3	145	3.6	109	9.8	7.38	23.7	143	4	107	7.33	22.7	138	4.2	107	10.6	40	15000
11	RADHA	45/F	27503	1	7.35	20.9	144	3.9	107	11.4	7.31	20.8	140	3.8	105	7.22	20.2	137	4.1	111	10.7	50	20000
12	MUNUSAMY	50/M	32923	1	7.35	20.9	137	3.9	107	13.5						7.33	19.5	141	3.9	105	13.7	25	9000
13	JAYAMURUGAN	43/M	33697	2	7.4	23.1	139	4.3	97	11.5	7.39	22.5	138	4.2	102	7.27	19.2	133	4.2	105	12	50	21000
14	SILAMBARASI	28/F	42724	1	7.37	20.3	143	4.3	102	12	7.34	19.8	140	4	105	7.28	18.1	146	3.7	106	12.3	45	18500
15	LOGANATHAN	60/M	41329	2	7.38	21.6	140	4.6	97	12.7						7.34	21.2	141	4.4	100	12.3	20	7500
16	KAMALAMMAL	60/F	39434	2	7.36	20.1	144	3.6	112	11	7.36	20.3	145	3.8	110	7.4	19.3	142	3.9	108	10.3	35	11000
17	KALIYAPERUMAL	53/M	43996	1	7.33	21.6	144	3.8	113	14.1						7.28	19.7	146	3.6	116	14.3	25	9500
18	RAJENDRAN	55/M	36378	1	7.35	23.6	144	4.3	114	12.6						7.39	22.5	140	4.5	98	11.5	25	10000
19	SARANYA	24/F	44943	1	7.37	20.8	140	4.7	109	11.5						7.36	19.1	140	4.5	111	11.8	20	7000
20	SANTOSH KUMAR	32/M	44443	1	7.38	21.7	142	4.2	112	13.9	7.37	21	140	4	112	7.32	19.7	135	4.3	108	14.2	40	15000
21	KUKAN SARKAR	22/M	47462	1	7.36	22.9	142	4.5	98	15.2	7.32	22.3	140	4.6	102	7.28	19.8	137	4.9	107	14.8	35	13000
22	JAYAKUMAR	40/M	48784	1	7.37	23.9	142	4.3	101	13.7						7.35	22.3	144	4.1	105	13.2	25	10500
23	LAKSHMANAN	55/M	50088	1	7.34	21.7	139	4.1	107	11.8	7.32	21.1	142	3.7	110	7.25	19	134	3.7	112	11.2	45	17000
24	DHANDAPANI	44/M	52399	1	7.4	21.2	137	3.6	98	10.7						7.36	20.2	134	3.8	102	11.8	20	7000
25	PRATAP	22/M	52911	1	7.45	21.1	136	4	97	11.5						7.42	21	139	4.2	101	11.1	20	6500
26	NAGAVALLI	34/F	50503	1	7.35	23.6	140	3.9	110	10.8						7.29	21.6	142	4.2	113	10.6	25	8500
27	ANITHA	28/F	49211	1	7.44	20.7	141	3.6	103	11.6	7.4	20.1	139	3.8	107	7.29	18.6	134	4.1	108	10.9	50	22500
28	KASALAKUMARI	48/F	52992	1	7.38	22.7	141	3.7	99	10.3						7.38	22.6	137	3.9	103	9.9	20	8000
29	MUNIYAMMAL	57/F	52959	2	7.41	23.2	144	3.9	105	11.2						7.35	22.2	140	4.2	108	10.1	25	9500
30	ANTHOSH	51/M	52094	1	7.46	21.3	139	3.7	109	10.8						7.43	21.1	135	4	107	11	20	8500
31	VARALAKSHMI	22/F	58886	1	7.41	22	138	3.9	102	11.2						7.4	21.3	140	3.6	105	11	20	7500
32	BASHEER	54/M	55200	2	7.43	22.4	142	3.7	98	11						7.37	21.6	139	4	108	11.3	25	9000
33	MANIMEGALAI	24/F	54737	1	7.34	20.9	137	4.3	106	13.2						7.31	21.4	140	4.1	110	13	20	7000
34	DURAIPILLAI	57/M	60743	1	7.36	21.9	143	4.6	103	12.8	7.3	21.4	141	4.5	109	7.25	19.6	137	4.9	107	12.4	40	16000
35	KUMAR	39/M	55612	1	7.33	20.7	138	4.2	96	13.4						7.31	20.1	140	4	99	13.1	20	9000
36	BALU	40/M	63480	1	7.41	21.7	136	3.8	97	13	7.4	21.4	140	3.9	104	7.37	20.7	142	4.2	102	12.8	40	18000
37	SUJATHA	30/F	62063	1	7.38	21.5	142	4.3	109	12.9	7.35	21.1	139	4.4	107	7.29	19.9	138	4.1	103	11.2	35	12500
38	IMMANUEL	53/M	55603	1	7.37	22.4	142	4.1	99	12.1						7.32	21.7	139	4.1	103	11.8	25	9000
39	MANICKAM	45/M	64923	1	7.42	22.7	144	3.9	103	10.8	7.4	22.3	145	4	106	7.36	21.6	140	4.3	101	10.4	35	12000
40	JOTHI	42/F	59673	1	7.37	21.9	146	3.8	107	11.1						7.35	20.8	139	4.2	102	10.8	20	8000